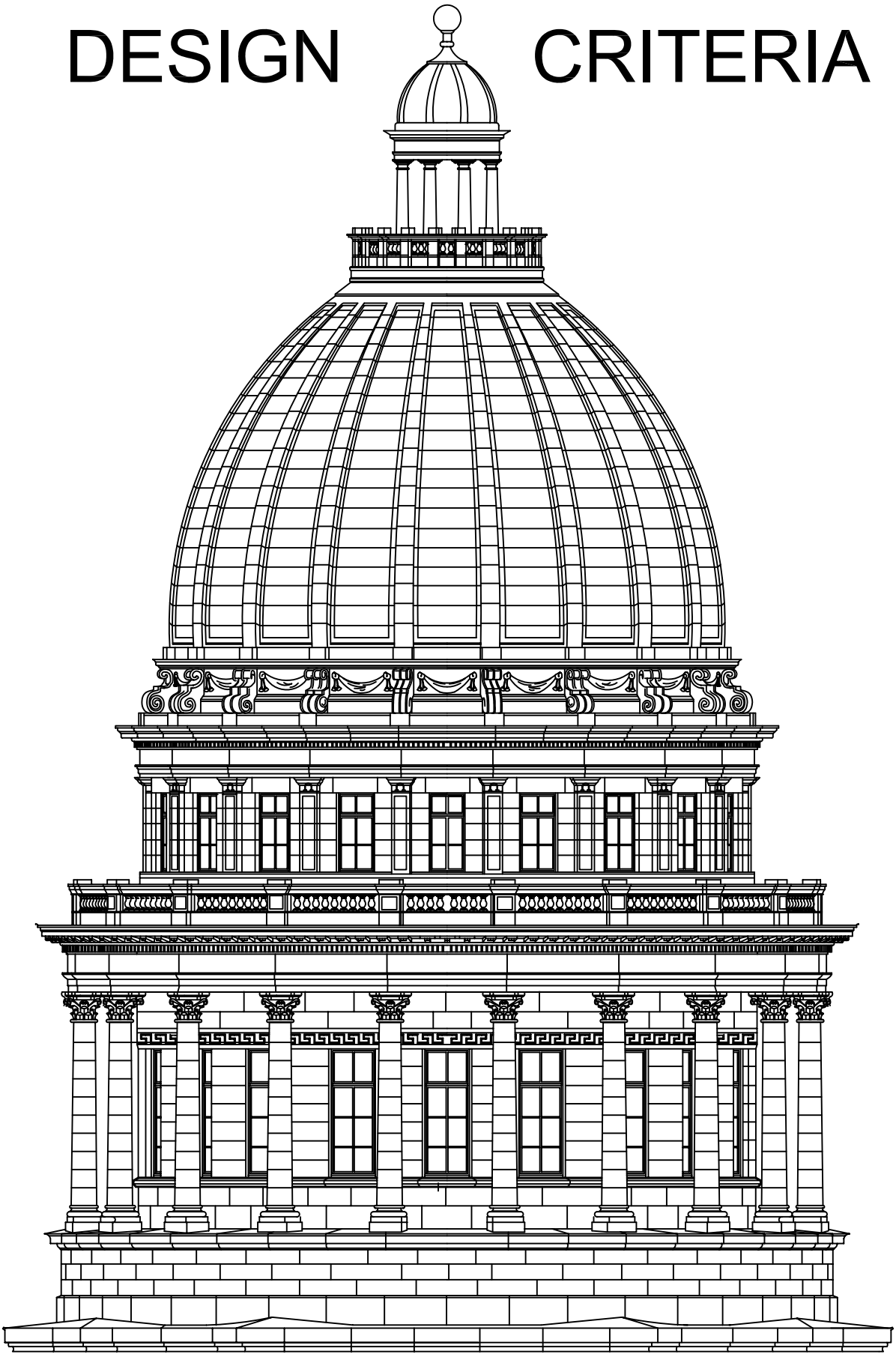
March 10, 1995

DESIGN CRITERIA



State of Utah - Department of Administrative Services

Division of Facilities Construction and Management

FORWARD

The Design Criteria contains specific information and instructions for the preparation of Contract Documents for facilities administered by the Division of Facilities Construction and Management ("DFCM"). The Design Criteria also lists the applicable codes and regulations.

The purpose of the Design Criteria is to provide detailed instruction for designers of state-owned buildings intended to serve a specific purpose. The Design Criteria are intended to further delineate and supplement industry recognized standards, codes and guide specifications. Many of the criteria are based upon the experience of DFCM and the input of professional and industry representatives.

This document is divided into six sections for ease of use.

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SECTION 1 CODES AND INDUSTRY CRITERIA

New and Remodeled Facilities:

The following is a list of rules, standards and codes, including those adopted or published, which the Architects and Engineers must comply with in designing facilities for the State of Utah. Any reference in the Design Criteria to rules, standards and codes shall refer to the list of the adopted and published documents listed below.

The Design Criteria interprets and explains many of the applicable provisions of the documents listed below. The rules, standards and codes listed below are hereby incorporated by reference herein.

The listed rules, standards and codes as well as the Design Criteria shall be read together as a whole in order that all provisions may be operative. In case of conflict between any of the provisions of the rules, standards, codes and the Design Criteria, the most stringent requirement shall govern. When none of the listed rules, standards and codes as well as the Design Criteria address an issue, contact the DFCM.

1.1 Rules, Standards and Codes:

Uniform Building Standards Act. Contact Department of Commerce, Division of Occupational and Professional Licensing for adoptions with current amendments of the following codes:

Uniform Building Code
Uniform Mechanical Code
Uniform Plumbing Code
National Electrical Code

Contact appropriate agency for most current copy of the following:

State of Utah, Boiler and Pressure Vessel, Rules as administered by the Labor-Industrial Commission of Utah, Division of Boiler Inspection. The Boiler Act of 1967 as authorized by the Utah Code Annotated.

Utah Occupational Safety and Health Rules - General Standards administered by the Labor-Industrial Commission of Utah.

Food Service Sanitation Rules, administered by the Department of Health, Division of Environmental Health, Bureau of Drinking Water/Sanitation as authorized by the Utah Code Annotated.

State of Utah Public Drinking Water Rules, Parts I & II, administered by the Department of Health, Divison of Environmental Health, Bureau of Drinking Water/Sanitation as authorized by Utah Code Annotated.

Rules relating to the Utah Indoor Clean Air Act, 1987 administered by the Department of Health as authorized by Utah Code Annotated.

Underground Storage Tank Act 1989 as authorized by Utah Code Annotated as administered by Utah Department of Health.

ASHRAE/IES 90.1 (Latest Edition) - Energy Efficient Design of New Buildings/Except Low-Rise Residential Buildings.

U. S. Department of Justice Federal Registers - Americans with Disabilities Act.

Life Cycle Cost Guidebook, per rules (R23-6) for Life Cycle Costing administered by Department of Administrative Services, Division of Facilities Construction and Management as authorized by Utah Code Annotated. (State Owned Facilities Only).

1.1 Rules, Standards and Codes: (Continued)

Air Conservation Act as authorized by the Utah Code Annotated 1981, pertaining to air contaminants, source, air pollution and asbestos. Implementation of this act, in part, per rules R307-1-8 Asbestos Certification, Asbestos Work Practices and AHERA, Implementation.

American National Standard Safety Code for Elevators and Escalators, ANSI/ASME A17.1, administered by Labor-Industrial Commission of Utah, Department of Occupational Safety and Health Elevator Division.

Environmental Protection Agency (EPA): Regulations for Asbestos - Code of Federal Regulations Title 40, Part 61.

Environmental Protection Agency (EPA): "Guidance for Controlling Asbestos containing materials in Buildings", EPA 560/5-85-024.

Rules (R23-1) for the procurement of construction as amended which calls for A/E specifications to "encourage competition and not be unduly restrictive" as authorized by the Utah Code Annotated.

State Procurement Code - Source Selection and Contract Formation as amended.

1.2 Related Industry Publications:

The intent of the following list of publications is to utilize design approaches, methods, practices and the specification of products and materials that are consistent with recognized industry standards.

The State of Utah does not have the resources to measure, compare and evaluate specified products and materials. Therefore, the references listed below are used to indicate the levels of quality necessary for DFCM approval of the Contract Documents.

ARCHITECTURE: * Uniform Code for Building Conservation.

* Uniform Code for the Abatement of Dangerous Buildings.*

American National Standard Safety Code for Elevators and Escalators, ANSI/ASME A17.1 with Appendix "F".

STRUCTURAL: American Institute of Steel Construction (AISC) with Commentary with no exclusions.

Load and Resistance Factor Design by AISC.

Portland Cement Association (PCA) publications and standards.

Concrete Reinforcing Steel Institution (CRSI) publications.

ACI 318 Building Code Requirements for Reinforced Concrete and all other publications.

Post-Tensioning Manual by the Post-Tensioning Institute.

Western Lumber grading Rules 88 with Supplement.

American Institute Timber Construction (AITC) publications and standards.

American Plywood Association (APA) publications and standards.

* Codes which have been submitted to the Uniform Building Code Commission for use by the State of Utah.

1.2 Related Industry Publications: (Continued)

STRUCTURAL (Continued):

American Iron and Steel Institute (AISI) Specifications for the Design of Cold-formed Steel Structural Members.

American Welding Society ANSI/AWS D1.1 Structural Welding Code.

American Welding Society Standards AWS D1.3 Structural Welding Code Sheet Steel.

Steel Joist Institute (SJI) for joists and girders.

Steel Deck Institute (SDI).

Applied Technology Council (ATC) publications.

Steel Structures Painting Council (SSPC), Volumes 1 & 2.

Structural Engineers Association of California (SEAOC) Recommended Lateral Force Requirements with Commentary.

Masonry Institute of America (MIA) publications.

National Concrete Masonry Association (NCMA) publications.

Brick Institute of America (BIA) publications.

International Conference of Building Officials (ICBO) Research Reports.

ELECTRICAL:

Insulated Cable Engineers Association (ICEA).

American Institute of Electrical Engineer's Electrical Power Systems and Grounding in Commercial Construction.

National Electrical Safety Code (NESC).

Illuminating Engineers Society (IES).

Standards of the National Electric Manufacturer's Association (NEMA).

American National Standards Institute (ANSI).

Institute of Electrical and Electronic Engineers (IEEE)

1.2 Related Industry Publications: (Continued)

MECHANICAL:

TITLE	PUBLISHER	REFERENCE
ASHRAE Handbook	ASHRAE	Fundamentals Volume
ASHRAE Handbook	ASHRAE	Refrigeration Volume
ASHRAE Handbook	ASHRAE	HVAC Systems & Application Volume
ASHRAE Handbook	ASHRAE	Equipment Volume
HVAC Duct Construction Standards-Metal & Flexible, First Ed. (1985)	SMACNA	SMACNA
HVAC Systems - Duct Design, 2nd Ed. (1981)	SMACNA	SMACNA
Methods of Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter	ASHRAE	ASHRAE 52
Boiler and Pressure Vessel Code (eleven sections) (1986)	ASME	ASME
Control and Safety Devices for Automatically Fired Boilers (CSD.1a is an addenda to 1982 ed.)	ASME	ANSI/ASME CSD.1-1982 CSD.1a-1984
Centrifugal Water-Chilling Packages	ARI	ARI 550
Reciprocating Water- Chilling Packages	ARI	ANSI/ARI 590
Thermal Environmental Conditions for Human Occupancy	ASHRAE	ANSI/ASHRAE 55
Energy Management Control Systems	ASHRAE	ASHRAE 114
Safety Code for Mechanical Refrigeration	ASHRAE	ANSI/ASHRAE 15

1.2 Related Industry Publications: (Continued)

MECHANICAL:

Ventilation for Acceptable Indoor Air Quality	ASHRAE	ASHRAE 62
Industrial Ventilation	ACGIH	ACGIH
ASPE Databook	ASPE	Fundamentals Volume
ASPE Databook	ASPE	Special Systems Volume

ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
ARI	Air-Conditioning and Refrigeration Institute
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
ASME	The American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association.

SECTION 2 GENERAL DESIGN POLICIES AND REQUIREMENTS

2.1 Design Policy: The design of State-owned facilities shall be aesthetically compatible with the type and importance of the facility and the abutting properties. It should be economically efficient, considering the function to be performed, the life of the function, habitability, first costs, maintenance costs, energy conservation, and operational costs. The design shall provide a facility that meets the functional requirements of the user agency and has a reasonable degree of flexibility to permit future reasonably foreseeable changes in use.

2.2 Selection and Use of Materials: Drawings and specifications shall provide a minimum of three brands of competitive materials, whenever possible. The fact that a material is new or relatively new does not necessarily bar its use. A fact that material has been used in the past does not automatically qualify it as meeting the current criteria. If a sole source of material is necessary, authorization must be obtained from the Director of DFCM.

2.3 Fire and Safety Protection: Fire and safety protection shall be incorporated into the project design as required by the State Fire Marshal's Office.

2.4 Project Design Phases: The project design will usually be separated into three principal phases. DFCM will provide written approval to proceed to each new phase at the successful completion of each previous phase. The phases are:

A. Schematic
B. Design Development
C. Contract Documents

2.5 Drawing and Specification Relationship: Construction claims often result from conflicts between uncoordinated drawings, notes and specifications. Therefore, it is necessary that drawings, notes and specifications be coordinated so as to minimize conflicting provisions.

SECTION 2 GENERAL DESIGN POLICIES AND REQUIRMENTS

2.6 Life Cycle Cost Analysis: A Life Cycle Cost Analysis will be applied to decision making by DFCM, to the extent appropriated by the legislature for the following facility acquisition and design activities:

ACTIVITY	REQUIRED
A. Programming:	
1. Site Selection	as feasible
2. Existing Facilities	over 30,000 GSF
3. Energy Conservation	always
4. New Facilities	over 30,000 GSF
B. Design for Construction:	
1. New Construction	over 30,000 GSF
2. Renovation	over 30,000 GSF
3. Energy Conservation	always

DFCM will conduct Life Cycle/Value Engineering reviews of proposed designs at the end of Schematic and Design Development Phase.

SECTION 2.1 DRAWINGS

2.1.1 Scope: This section provides the information and criteria for all prepared drawings.

2.1.2 Drawing Types: The Architect and Engineer shall work with DFCM's Project Coordinator in determining the drawing format.

2.1.3 Isometric and Perspective Views: Renderings in isometrics, perspectives photographs, reproductions or pictorials may be used on drawings when necessary to clarify a design.

2.1.4 Models and Renderings: The use of models and renderings may be used to supplement and explain the design.

2.1.5 Contract Documents: These documents shall convey to all concerned (contractor, manufacturer, fabricator, etc.) the information necessary for the required work. It is essential that the documents be accurate and explicit. All elements of the Contract Documents shall be properly coordinated to minimize conflicts between drawings, specifications and:

A. Be sufficient for completion of the project and include site information, the extent, size, shape and generic types of materials, and the relationship between materials. Some duplication of items included in specifications may be desirable in the structural general notes for emphasis. If duplication does occur, the Architect and Engineer must carefully review the Contract Documents for consistency.

B. Show permanent survey control points (bench marks).

C. Complete finish, door, window, hardware and fixture schedules.

D. Show project number on all drawings.

E. List all drawing titles in an index.

F. Contain sufficient dimensioning to construct the facility.

G. Show the relationship of existing utilities, easements, property interests and encumbrances that the Architect and Engineer have knowledge of or should have knowledge of by reasonable investigation, to those utilities, easements, property interests and encumbrances designated as new.

SECTION 2.1 DRAWINGS

2.1.6 Shop Drawings: Shop drawings are defined in the General Conditions.

2.1.7 Record Drawings: Record Drawings are defined in the General Conditions. Their accuracy is of paramount importance. Special attention should be given to accurately recording on-site utilities.

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFICATIONS AND COSTS

2.2.1 The quality, technical accuracy and coordination of all work by the consultant is of utmost importance to DFCM, consequently; the consultant shall have a functional and logical quality control program to minimize errors or deficiencies prior to submitting drawings and specifications to DFCM. At final submission, the checker's initials shall appear in the appropriate area of the cover or title block. Where feasible, it is recommended that the original designer not check his own work. DFCM plan reviews do not replace Architects/Engineers responsibility for quality control.

2.2.2 The documents submitted to DFCM at Schematic, Design Development and Contract Documents Phase shall include a copy of the following check-list with each phase submittal:

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFCATIONS AND COSTS

2.2.3 SCHEMATIC DESIGN PHASE CHECKLIST:

ARCHITECTURAL:

_____ Area Comparison in tabular form to the design program of both net and gross areas. Include net to gross floor area ratio. (Include custodial, telephone, mechanical, elevator, electrical rooms and utility tunnels in the gross square footage). Identify any discrepancy with design program. Check for excessive volume and check for space to accommodate program furnishings.

_____ Room relationships according to program: Explain in written form any deviations from functional relationships required by the design program.

_____ Internal circulation patterns: Provide graphic evidence of direct circulation and efficient pedestrian circulation patterns.

_____ Submit plans of each floor, elevations or profiles, a typical cross-section through the facility in the North-South, East-West directions. Plans should show custodial, telephone, mechanical, elevators, electrical rooms and tunnels. Provide room function or name. Drawings must indicate selections of major interior and exterior materials including pavement types.

_____ Written Code Compliance to include the U.B.C. Occupancy Type, Construction Type, allowable areas and heights, code search to also include plumbing and handicap requirements.

COST ESTIMATE:

_____ (See Estimating Section 2.3).

SPECIFICATIONS:

_____ Provide an outline of the proposed project specifications. (See Spec. Section 2.5).

SITE UTILITY:

_____ Submit a separate Site Utility Plan to scale reflecting the following:

a. Existing and proposed tunnels, pump stations, transformers, emergency generators, and mechanical equipment.

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFCATIONS AND COSTS

2.2.3 SCHEMATIC DESIGN PHASE CHECKLIST (Continued):

b. Location, availability and capacity of existing and proposed culinary and secondary water lines, storm and sanitary sewers, fire lines, telecommunication lines and cables, power lines, ducts, (overhead and buried) and natural gas lines.
c. Location of manholes, signs, junction boxes and easements on plan reflecting existing and proposed topography and grades.
d. Property boundary lines and/or project limit lines.

SITE DEVELOPMENT:

_____ Site Orientation: Graphic explanation of orientation of the facility and design elements.

a. Sun (Solar gain, shadow patterns, etc.)
b. Wind (Snow drift, fume dispersal, etc.)
c. Moisture (Snow accumulation, snow removal, ice build-up, surface drainage, etc.

_____ Submit a separate Site Development Plan to scale reflecting the following:

a. General drainage scheme.
b. General site grading with 1.) existing contours 2.) proposed contours.
c. Parking areas with approximate stall count.
d. Relationship of parking to entries, service areas, orientation directories, dumpsters, etc.
e. Proposed walks, drives and specialty pavement in relationship to existing.
f. Proposed and existing retaining walls, screen walls, fences and ramps.
g. Adjacent site conditions, i.e. zoning, masterplan and facilities, etc.

_____ Submit a Schematic Planting Plan to scale reflecting the following:

a. Evergreen vs. Deciduous trees.
b. Lawn areas vs. shrub beds.
c. Cosmetic grading/drainage.
d. Proposed site retainage solutions.

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFCATIONS AND COSTS

2.2.4 SCHEMATIC DESIGN PHASE CHECKLIST (Continued):

Submit a Schematic Irrigation Plan to scale reflecting the following:

a. Design philosophy.
b. Irrigated areas vs non-irrigated
c. Water need/consumption analysis.
d. Water source and pressure.
e. Power source.
f. Planned distribution methodology. (Head layout and piping not required at this stage.)

1. Drip
2. Bubbler/Flood
3. Spray
4. Impact/Rotor
5. Etc.

STRUCTURAL:

Submit in a written description form or drawing form to scale but not necessarily dimensioned a proposed foundation plan, proposed seismic/wind lateral force resisting system, floor and roof framing. The drawing form is the preferred submittal. Submit on drawing or written description form the Design Criteria utilized.

MECHANICAL:

The engineer should provide a brief written description of the proposed system(s) for the facility including but not limited to:

a. Type of air distribution system.
b. Heat generating systems.
c. Ventilating systems.
d. Refrigeration systems.
e. Plumbing systems.
f. Fire protection system.

The major components such as (boiler, chiller, air handlers, etc.) should be located on the drawings. The equipment approximate capacities if known at this time should be indicated on an equipment schedule.

ELECTRICAL:

Provide a written description and/or drawings of all elements of design including but not limitied to risers, schedules, power and lighting layouts, emergency power requirements, fire alarm, telecommunications, data processing, and security.

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFCATIONS AND COSTS

2.2.4 DESIGN DEVELOPMENT PHASE CHECKLIST:

ARCHITECTURAL:

_____ Area Comparison in tabular form to the design program of both net and gross areas. Include net to gross floor area ratio. (Include custodial, telephone, mechanical, elevator, electrical rooms and utility tunnels in the gross square footage). Identify any discrepancy with design program. Check for excessive volume and check for space to accommodate program furnishings.

_____ Room relationships according to program: Explain in written form any deviations from functional relationships required by the design program.

_____ Internal circulation patterns: Provide graphic evidence of direct circulation and efficient pedestrian circulation patterns.

_____ Submit plans of each floor, roof drainage plan, elevations and profiles with floor elevations, cross-sections representative of building and site conditions with key elevations identified through the facility in the North-South, East-West directions.

_____ Plans should show custodial, telephone, mechanical, elevators, electrical rooms and tunnels. Provide room function or name. Submit an outline specification with identification of both interior and exterior finishes.

COST ESTIMATE:

_____ (See Estimating Section 2.3).

SPECIFICATIONS:

_____ Provide a preliminary project specification that addresses Part 1 - GENERAL, Part 2 - PRODUCTS, Part 3 (Optional) - EXECUTION . See Specification Section 2.5 for further information.

SITE UTILITY:

_____ Submit a refined Site Utility Plan to scale reflecting all modifications required by the Schematic Design Phase review. Include all previously noted elements including the following:

a. Proposed grades for utilities
b. Elevation of boxes, pads, and junctions, etc.

2.2.4 DESIGN DEVELOPMENT PHASE CHECKLIST (Continued):

c. All refinements to utility plan encountered to this stage of the work.
d. Standard utility details
e. Standard utility notes.

SITE DEVELOPMENT:

_____ Deviation from previous Schematic Design submittal, if any, regarding site orientation.

_____ Refinement of Site Development Plan coordinated with underground utilities and site features dimensioned and to scale reflecting each element required in the Schematic Design Phase submittal in addition to the following:

a. Critical spot elevations on grading plan.
b. Location and sizes of transformer pads, utility boxes, poles.
c. Identification of handicap parking stalls, access ramps, curb cuts, etc.
d. Location of all curbs, walls, walks, drives, retaining devices, ramps, fences screens, signs, lighting, (in relationship to major trees).
e. Standard details

_____ Refinement of Planting Plans reflecting the following:

a. Proposed plant schedule of materials.
b. Plant list showing botanical and common names and container/ball sizes.
c. Standard planting details proposed.

_____ Refinement of Irrigation Plan to scale reflecting the following:

a. Irrigation head locations
b. Irrigation head types.
c. Complete materials schedule.
d. Standard irrigation details.
e. Standard irrigation notes.
f. Outline specification.

STRUCTURAL:

_____ Submit in drawing form to scale with some dimensioning the selected foundation system, selected seismic/wind lateral force resisting system, floor and roof framing and typical details. Submit on the drawing the Design Criteria utilized.

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFCATIONS AND COSTS

2.2.4 DESIGN DEVELOPMENT PHASE CHECKLIST (Continued):

MECHANICAL:

_____ Design intent should be demonstrated for HVAC, Plumbing, Fire Protection and Site Work. Duct layout may be shown in single line format. Include equipment schedules with capacities listed. Design intent must be sufficiently described so that first, energy, and maintenance costs for the system can be estimated during the Value Engineering process. See Section 5 Mechanical Design Criteria - "Basis of Design" for description of mechanical submittal.

ELECTRICAL:

_____ All elements of design including but not limited to risers, schedules, power and lighting layouts, emergency power requirements, fire alarm, telecommunications, data processing, and security.

Return DFCM's Schematic Design Phase review comments (drawings and specifications and cost estimate) with response.

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFCATIONS AND COSTS

2.2.5 CONTRACT DOCUMENT PHASE CHECKLIST:

_____ Cost Estimate: Completion of a detailed material determination based on CSI format escalated to bid date. See Cost Estimating Section.

Specifications and General Conditions: The Architect/Engineer shall complete the document including all pertinent bidding information and forms (deposit, bid opening date and place, liquidated damages, document distribution, supplementary General Conditions and special conditions.

_____ Energy Analysis: Demonstrate compliance in accordance with Energy Code for Commercial and Highrise Buildings (Codification of ASHRAE/IES 90.1-1989). Compliance with ASHRAE Standard 90.1 shall be accepted in compliance with the Model Energy Code. Compliance forms are available at DFCM and must be submitted as a complete package by the prime Architect/Engineer. Separate submittals from each discipline do not satisfy this requirement.

_____ Drawings: Complete all drawings: Title Sheet, Civil-Site and Vicinity Plans, Site Utilities, Site Development, Planting, Irrigation, Architectural, Structural, Mechanical HVAC, Plumbing and Fire Protection, and Electrical in regard to the requirements in the Drafting Section.

_____ Return DFCM's Design Development Phase review comments (drawings and specifications), with response.

_____ Resubmit Mechanical Basis of Design with corrections.

_____ Submit Structural Engineer's calculations. When lengthy computer calculation approaches are utilized, submit only the final results (not input data).

SECTION 2.2 QUALITY CONTROL OF DRAWINGS, SPECIFCATIONS AND COSTS

2.2.6 FINAL CHECK (PRE-BID REVIEW):

A. The Architect/Engineer shall return the previously submitted Contract Documents with comment sheets and include a response to the DFCM and institution/agency comments.
B. After coordinating and following up on any comments from DFCM document review, submit drawing and specification original cover sheet for required Agency and DFCM signatures.

2.2.7 BID PHASE:

A. Coordinate bid date and time with DFCM Project Coordinator and Contract Coordinator.
B. The Architect/Engineer, after obtaining necessary staff and agency head approvals shall print Contract Documents as required per the A/E Agreement and distribute them to the bidders and DFCM. If documents are needed in excess of agreement, contact DFCM's Contract Coordinator.
C. The Architect/Engineer shall answer all bidders inquiries and issue addenda. Review all changes with DFCM's Project Coordinator before issuing as an addendum. All addendum documents must be circulated to each entity holding documents.
D. Though these criteria limit the number of Alternates to six (6), there may be occasions when more alternates can be justified. In this case, justify with project coordinator, prepare the Bid Tab Form and submit form to DFCM's Contract Coordinator.
E. The Architect/Engineer shall obtain a copy of the Prequalification List of contractors from DFCM. The A/E shall verify prequalification of contractors from this list.

2.2.8 DFCM will not send Contract Documents to the Fire Marshal's Office, Board of Health, Bureau of Air Quality or the other regulatory agency or user agency/institution. The Architect/Engineer shall review the Contract Documents with the above agencies and obtain signatures for approval.

SECTION 2.3 COST ESTIMATING

2.3.1 COST ESTIMATING:

The Architect/Engineer is responsible to bring the project in within budget. If a professional estimator is used, the Architect or Engineer remains responsible for the estimate to DFCM. Therefore, the following shall be utilized to assist in the preparation of the cost estimate:

a. Headings – Detail and Summary Cost Reports: All cost estimating reports should include:

1. Project title and location
2. Owner and DFCM Project No.
3. Architect
4. Estimating Firm
5. Design Phase (Schematic, Design Development or Construction) and date
6. Project Gross Square Footage

b. Market Conditions: A review of market conditions should be made when preparing each cost estimate. It should consider the effect on project costs of bidding competition, seasonal conditions, job site conditions, area productivity, adequacy of fabrication, material cost and availability and labor costs and availability. Consider the optimum method of construction, i.e., whether by one large contract, several small contracts, or by sequentially phased construction.

c. Line Items: Estimates for all submittals shall include all labor and material costs or in place costs for each item, including equipment which would usually be furnished by a contractor and permanently built-in or attached to the structure, and items with fixed utility connections. General Contractor overhead and profit should be added separately. Such costs will be based on current prices. Each estimate should indicate escalation to bid date.

d. Cost Distribution: The estimates shall indicate the gross square foot area of any buildings. The estimates shall summarize the cost of any addition or extensions to an existing building (excluding modifications to the existing building). The estimates shall also indicate separately the cost of each type of outside utility, including, but not limitied to, the water supply system, sewer system and electrical system.

2.3.1 COST ESTIMATING (Continued)

e. Back-up Data: Back-up data for lump sum prices shall be furnished to DFCM upon request. The Architect/Engineer shall use its best efforts to identify the prices of suppliers of materials and labor from those suppliers regularly doing business in the State of Utah and those suppliers in the local area of the project.

f. Profits: There shall be a calculation of the Contractor's profit as a percentage of the total material, labor and overhead costs. Factors that determine the percentage of the profit includes: a) the amount of the competition, b) the size of the Project, c) type of work, d) foreseeable hazards, e) current construction activity, and f) other related factors. The percentage of profit that each Project should have is individually determined by the Architect, Engineer or professional estimator.

g. General Conditions: The estimate should include provisions for General Conditions etc.

h. Escalation: Cost estimates shall be escalated from the date of preparation of the cost estimate to bid date to reflect the anticipated cost growth during this period of time. The escalation cost should be added as a percentage cost, so the cost can easily be updated.

i. Preparation: In preparing the detailed breakdown for the estimates, the unit or lump sum prices shown will include the contractor's direct cost of only the intended work. To complete the estimate, the General Conditions, Bonding, Overhead and Profit, shall be added separately to reflect the total current cost of the work. To compensate for inflation on contracts, escalation costs shall be added to the estimate projected to the anticipated bid date. In the event the estimated contract cost exceeds the project budget, the following additional information must be provided:

    1. Suggestions as to which items, if omitted, will still provide a usable facility.
    2. An estimate of cost savings attributable to each of the suggested omissions or reductions.

j. Project (Construction) Contingency: The estimate shall not include a construction contingency. Construction contingency as budgeted by DFCM is an allowance for unforseeable occurences after the time of contract award. It is an allowance for some adverse or unanticipated conditions not susceptible for predetermination from the data at hand during engineering and design, but which must be expressed or represented in the project cost estimate. Ordinarily, this allowance is for latent difficulties,

2.3.1 COST ESTIMATING (Continued)

such as unforeseeable relocations or foundation conditions, encountering utility lines, or other unforseen problems beyond interpretation at the time of contract award. It is not an allowance for omissions of work items which are known to be required but for which fairly accurate quantities have not yet been determined. Reasonable allowances for all forseeable work items must be made in the estimate.

k. Projects with Federal Funds: DFCM Projects utilizing federal funds may require wage rates per Davis-Bacon Act. Estimator shall verify with DFCM's Project Coordinator as to whether special wage rates apply.

2.3.2 SCHEMATIC PHASE COST ESTIMATE:

This estimate is an early design type estimate based on a CSI Format with corresponding CSI Division Headings submitted in conjunction with schematic phase documents. The format estimate shall consist of a Summary Cost Estimate Report (See example - Fig. 2.1) that includes the following:

a. Cost estimate on square foot basis on use types as appropriate-parking, utilities, circulation, office, lab, classroom, site improvements, hardscape, softscape, and irrigation system. (For engineering estimates, incorporate appropriate unit costs for specialized projects).
b. Include General Conditions, Bonding, Overhead and Profit, and Design Contingency. Escalate information to bid date.
c. Include a written paragraph discussing market and other specific conditions relating to the project.
d. Economic Analysis: Design alternatives should be examined through the preparation of an economic analysis which shall be available upon request:

Examples:
One level versus multi-level construction.
Glass fiber reinforced concrete versus brick veneer.
Steel versus concrete.
Chilled water versus DX system.

Analysis shall include life cycle cost in which initial investment, operation, and maintenance costs shall be considered during the economic life of a structure. Economic analysis shall be prepared in accordance with generally accepted practice.

PROJECT TITLE:		DATE:	
OWNER:		DFCM PROJ. NO:	
ARCHITECT:		SCH, PHASE:	
ESTIMATING FIRM:		DESIGN DEV, PHASE:	
COMMENT:		COTRACT DOC. PHASE:	

SUMMARY COST ESTIMATE REPORT

SCI DIV. HEADINGS		TOTAL COSTS	% TOTAL	COST/SF
02	SITEWORK			
03	CONCRETE			
04	MASONRY			
05	METALS			
06	WOOD AND PLASTICS			
07	THERMAL AND MOISTURE PROTECTION			
08	DOORS AND WINDOWS			
09	FINISHES			
10	SPECIALTIES			
11	EQUIPMENT			
12	FURNISHINGS			
13	SPECIAL CONSTUCTION			
14	CONCEYING SYSTEMS			
15	MECHANICAL			
16	ELECTRICAL			
SUBTOTALS				
	PERCENTAGE			
GENERAL CONDITIONS				
BONDING				
OVERHEAD & PROFIT				
DESIGN CONTINGENCY*				
TOTALS				

* On Schimatic and Design Deelopment Phase Only

FIG. 2.1 SUMMARY COST ESTIMATE REPORT

SECTION 2.3 COST ESTIMATING

2.3.2.d SCHEMATIC PHASE COST ESTIMATE (Continued):

In most cases the preliminary status of design does not permit an accurate determination of quantities or pricing of individual items of material and equipment. The initial cost is developed through the use of lump sum costs based on available data. The basis of these costs, such as costs per square foot of building, per square yard of pavement, or per mechanical or electrical system shall be given.

2.3.3 DESIGN DEVELOPMENT PHASE COST ESTIMATE:

This estimate is to be detailed to the level of document development and based on the CSI format with corresponding CSI Division headings. The format estimate shall consist of a cost summary sheet that includes the following:

A. A Detailed Cost Estimate Report (See examples - Figures 2.1 and 2.2) escalated to bid date on use types as appropriate - parking, site improvements breakout including trees, shrubs, turf, soil/grading, irrigation system and specialty pavement, site furniture and lighting, utilities, circulation, office, lab, classroom, etc. (For engineering estimates, incorporate appropriate unit costs).

The estimate shall include allowances for General Conditions, Bonding, Overhead and Profit, Design Phase Contingency with escalation to bid date.

2.3.4 CONTRACT DOCUMENT PHASE COST ESTIMATE:

The estimate should include all design changes made up to bid date. A final design type estimate shall be submitted in conjunction with the Contract Documents. It is essentially an updated and more detailed version of the Design Development estimate and shall reflect the cost of the project.

The format estimate shall consist of a cost summary sheet that includes a refinement of the following:

A. Completion of a Detailed Cost Estimate Report (See examples - Figures 2.1 and 2.2) based on CSI format escalated to bid date on use types as appropriate - parking, site improvements breakout including Evergreen trees, Deciduous trees, shrubs, ground cover/perennials, sprinkling, soils, fine grading and miscellaneous other landscape elements, utilities, circulation, office, lab, classroom, etc. (For engineering estimates, incorporate appropriate unit costs). Include cost estimate for each alternate listed.
B. Include a written paragraph discussing market and other specific conditions relating to the project.

PROJECT TITLE:		DATE:	
OWNER:		DFCM PROJ. NO:	
ARCHITECT:			
ESTIMATING FIRM:		DESIGN DEV, PHASE:	
COMMENT:		COTRACT DOC. PHASE:	

DETAIL COST ESTIMATE REPORT*

DIVISION HEADING: 05 - METALS - (EXAMPLE)

ITEM #	SECT. NO.	DESCRIPTION	QTY/UNIT	UNIT COST	COST
				TOTAL	

DIVISION HEADING: 06 - WOODS AND PLASTICS - (EXAMPLE)

ITEM #	SECT. NO.	DESCRIPTION	QTY/UNIT	UNIT COST	COST
				TOTAL	

FIG. 2.2* DESIGN DEVELOPMENT OR CONTRACT DOCUMENT PHASE COST ESTIMATE

* Extent of cost estimate based on level of document development

SECTION 2.3 COST ESTIMATING (Continued)

The estimate shall include allowances for General Conditions, Bonding, Overhead and Profit, Design Contingency with escalation to bid date.

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SECTION 2.4 DRAFTING

2.4.1 GENERAL:

These criteria present information and minimum criteria for drawing preparation, their types and requirements, and applies to all drawings prepared for the DFCM. Show clearly and concisely the information that will be required by the contractor to bid and construct the facility. In addition to the plans, elevations, sections and details, the use of isometrics, pictorial views and models (when required) may be used to show or convey a particular advantage.

Prepare drawings for the following phases:

A. Schematic Phase.
B. Design Development Phase.
C. Contract Document Phase.

The drawings must be arranged in a logical sequence as follows:

A. Title Sheet.
B. Civil (Site and Vicinity Plans, Utilities).
C. Planting Plan.
D. Irrigation Plan
E. Architectural.
F. Structural.
G. Mechanical (HVAC).
H. Fires Protection.
I. Plumbing.
J. Electrical.

On small projects, the information noted immediately above may be compressed into fewer categories, but arranged in logical fashion. Also, the Contract Documents shall convey to the contractor, manufacturer or fabricator the information necessary for development of shop drawings and subsequent accomplishment of the required work. It is essential that the drawings be accurate and explicit. All elements of the work must be properly coordinated. All plans, evaluations, sections and details shall be free from superfluous or conflicting notes. To accomplish this, the Contract Documents shall show what is involved, where it is located, and what the physical dimensions are.

SECTION 2.4 DRAFTING

Every effort must be put forth to utilize recognized architectural/engineering abbreviations, legends, and standard details. The policy of DFCM is to utilize as much as possible those non-governmental standards which fully satisfy technical sufficiency.

2.4.2 DRAWING REQUIREMENTS:

Due to the long life that may be expected of most State-owned facilities and future needs for remodeling, where record drawings are reproduced many times, the following materials and drafting sheet sizes shall be used for all drawings.

Acceptable Drawing Sheet Sizes
Minimum 24" x 36"
Maximum 30" x 42"

Standardized size drawings shall be pre-printed with title, revision blocks and margins. All drawings shall be prepared on polyester film 3 mil thickness (minimum) and have a matte finish on at least one side to allow future marking of revisions. The drafting medium shall be preferably film leads (plastic leads) or ink if prepared by Computer Aided Drafting (CAD). Drawings smaller than 24" x 36" are not acceptable unless folded and bound in a project manual or specifications.

2.4.3 LINE CHARACTERISTICS:

Due to future planned micro-filming of all record drawings, increased attention shall be paid to opaqueness and uniform weights of lines to assure legible reductions and blowbacks as successive generations of prints are obtained. Only patterned, screened, or other proven reproducible shading techniques are acceptable. The use of graphic symbols presented in the "Architectural Graphic Standards" are acceptable to highlight special features; however, particular attention shall be given to graphic techniques to depict new and existing conditions.

2.4.4 LETTERING:

The size of lettering shall be legible when drawings are reduced to half size.

SECTION 2.4 DRAFTING

2.4.5 DIMENSIONS:

Horizontal dimensions shall be preferably related to a grid. Vertical dimensions shall be related to an established reference plane (such as the finished floor level) derived from an established bench mark. Dimensions under 1'- 0" shall be noted in inches. Exercise care in placement of dimension lines and (arrows/slashes) to convey clear intent. When a clear dimension is required by code, dimension to the finish face and note as such. Civil drawings and landscaping drawings may use decimal feet to define dimensions and elevations.

2.4.6 DRAWING FORMATS AND ORIENTATION OF VIEWS:

Preferably details shall be reserved for separate sheets. For methods of identifying sections, elevations and details, see Figure 2.3.

On large complex facilities, a small key plan shall be placed close to the title block to identify sections and details or expanded views. Match lines shall be used to depict continuation on more than one sheet.

Every plan view shall have a north arrow orientation. Preferably, facility north shall point to the top of the drawing sheet or to the left of the sheet. All disciplines shall prepare their drawings with consistent orientation once the north arrow direction is selected.

2.4.7 DRAWING SCALE:

Generally, plans, elevations, sections and details shall be drawn to scale. In the case of diagrams, isometrics, perspectives or otherwise, drawings not prepared to any scale, the word "NONE" shall be entered after "SCALE" in the space provided in the drawing title block. Drawings drawn to scale but later revised due to revisions (without redrawing) shall have the not-to-scale dimension underlined with a straight line. If extensive revisions to dimensions are made without redrawing, then the letters "N.T.S." (not to scale) shall appear in the space provided on the drawing format.

Civil/Site Development Drawings which include location maps, utility drawings, etc., shall be drawn using the engineering scales 1/1, 1/10, 1/20, 1/30, 1/40, 1/50, 1/60, or 1/100.

SECTION 2.4 DRAFTING

Reference Symbols

It is intended that section cut symbols, interior elevation symbols and other reference symbols be clearly understood easily identified and consistent throughut a set of documents.

Section cuts should have a prominent arrow indicator showing direction of view. All symbols should indicate a drawing title or identifier in alphanumeric form and should reference the drawing on which the section, detail, elevation, etc. appears. This symbolism should always appear as part of the drawing title.

EXAMPLE:

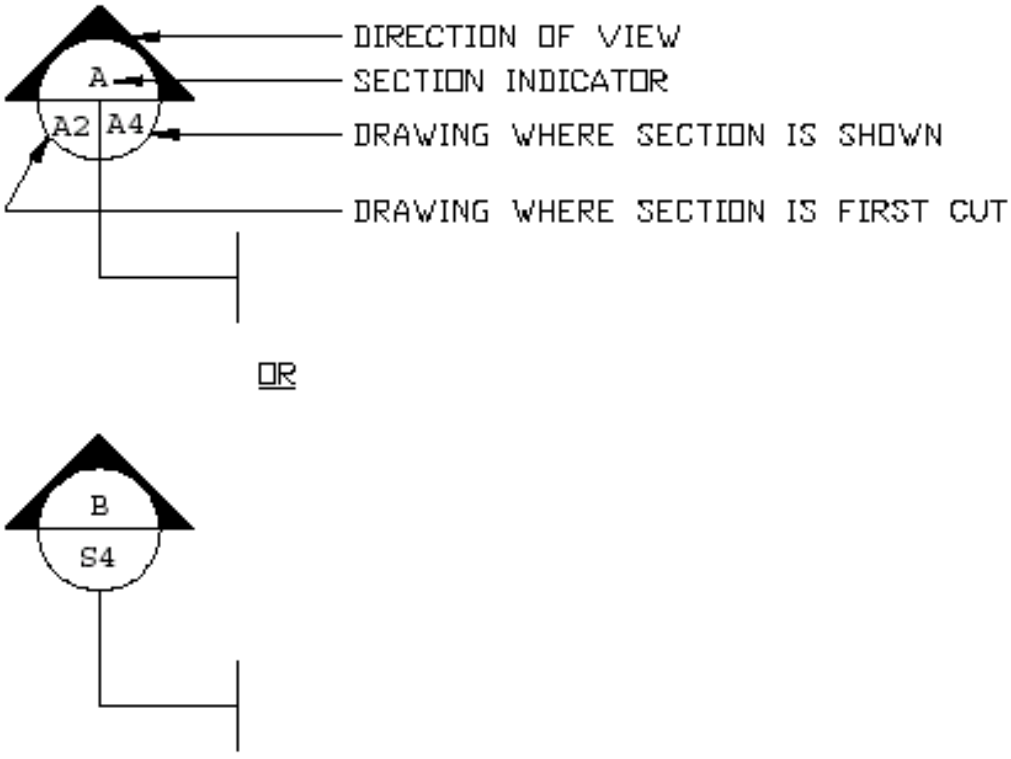

FIGURE 2.3 Method of Identifying Elevations and Sections

SECTION 2.4 DRAFTING

Architectural, Structural, Mechanical and Electrical drawings shall be drawn using the architectural scales 1/8", 1/4", 3/8", 1/2", 3/4", 1", 1 1/2" or 3" per foot.

Every effort shall be made to standardize orientation and scale of plan views so that all disciplines can check for interferences by means of overlays. Generally, to aid in this endeavor, all plan views shall incorporate the use of a design grid or column lines finalized to specific dimensions early in the Design Development Phase. These grid lines shall also be depicted in elevations, sections and details to aid in interpreting view orientation.

Landscape Architectural, Planting, and Irrigation System drawings shall be drawn at scales 1/8", 1/16", per foot or at 1/10, 1/20, or 1/30 scales.

2.4.8 COORDINATION OF DRAWINGS AND SPECIFICATIONS:

Drawings and specifications shall be coordinated. It is mandatory that the drawing preparer and the specification writer review the drawings during and after their completion to assure that information appearing on the drawings is clear and adequate. Avoid duplication of information and confusing or misleading terminology.

2.4.9 DRAWING ARRANGEMENT:

The following listing illustrates a typical sequence with contents of drawings developed for a discipline of work:

A. Title Drawing

1. State Seal with DFCM Decal.
2. Project Title with location map.
3. DFCM Project Number.
4. List of A/E consultant’s names, addresses, and phone numbers.
5. DFCM Approval Decal.
6. DFCM Design and Code Criteria Decal.
7. DFCM Pre-bid Staff Review Decal.
8. Title Block (optional).
9. Index of drawing sheets (optional location).
10. A separate drawing may be used for index for large facilities.
11. Contractors access routes to site.
12. Revision Block (optional).

SECTION 2.4 DRAFTING

B. Civil Drawings

1. Title and Revision blocks.
2. Site plan.
3. Vicinity map.
4. Utility plans with legend.
5. Grading and excavation information.
6. Survey information including permanent control points, bench marks and datum elevations.
7. Abbreviation list.
8. Plans, sections and details of site grading and utility trenches.
9. Registration seal (each drawing).
10. Notes.

C. Landscaping and Irrigation Drawings

1. Title and Revision blocks.
2. Landscape Architect Registration Seal (each drawing).
3. Plans of landscaping, irrigation and planting with major sections through site features.
4. Irrigation plan must reflect site topography.
5. Plans must reflect grading and drainage.
6. Plant and irrigation schedules and legends.
7. Standard and custom details of planting, irrigation, furniture, site lighting.
8. Prominent utility features, i.e., poles, boxes, enclosures. (Coordinate planting and other features with underground utilities).
9. Abbreviation list.
10. Notes.

D. Architectural Drawings

1. Title and Revision Blocks.
2. Registration seal (each drawing).
3. Legends.
4. Abbreviation lists.
5. Schedules: Door, room finish, equipment.
6. Plans of: Sub-basement, basements, first floor (including adjacent site), upper floors, reflected ceiling and roof. The Fire Protection System shall be coordinated with other building elements and the roof. Sprinkler head, smoke and heat detectors locations shall be shown on the reflected ceiling plans. Smoke and heat detectors shall be located a minimum of 3 feet from ceiling diffusers. See Article 2.4.9 (f) (g) for other information.
7. Elevations: exterior and interior.
8. Sections.
9. Details.
10. Notes.
11. Facility illustrations and pictorials as necessary.

SECTION 2.4 DRAFTING

E. Structural Drawings

DFCM frequently finds that structural plans are used for construction layout. Therefore, all structural plans shall be drawn to minimum scale of 1/8" per foot and be adequately dimensioned and coordinated with the other drawing disciplines. Elevations, sections and details shall have the facility assigned design grid lines referenced on the views for orientation. Major work point and bearing elevations shall be given in the Contract Documents. Top elevations of footings, foundations, bearing walls and bearing points shall be clearly expressed. Thickened slabs supporting non-load bearing walls shall have their centerline located by dimensioning to the nearest grid line. Masonry walls or other elements requiring extended observation shall be clearly noted on the drawings.

1. Title and Revision blocks.
2. Registration seal (each drawing).
3. Structural General Notes with Basis of Design.
4. Legends.
5. Abbreviations.
6. Standard details.
7. Decking, beam and column schedules, etc.
8. Foundation piling or shoring plans.
9. Floor and roof plans.
10. Sections.
11. Elevations.
12. Details.

F. Mechanical Drawings

Prepare enlarged plans for all boiler, mechanical and toilet rooms to a minimum scale of 1/4" per foot. Every effort shall be put forth to use expanded scales, detail plans and sections to clarify equipment and system arrangements. Typical drawing sections shall be taken through air handling equipment to depict ductwork arrangements. Provide invert elevations on sanitary waste lines and storm drains at pipe inlets, at manholes, vaults, at building foundation perimeter, changes in direction, etc. New and existing mechanical systems or equipment shall be graphically depicted with recognized drafting techniques by Contract Document Phase. All major duct runs shall be depicted dimensionally i.e., with no single line representation in the Contract Document Phase.

SECTION 2.4 DRAFTING

Mechanical Drawings(Continued)

1. Title and Revision blocks.
2. Registration seal (each drawing, except Fire Protection).
3. Mechanical keyed or referenced notes.
4. Legends which include HVAC, Plumbing, Fire Protection and control symbols.
5. Abbreviations.
6. Schedules for HVAC equipment and plumbing fixtures.
7. Diagrams and isometrics for waste and vent plumbing.
8. Utility site plan.
9. Plans for HVAC and plumbing including equipment pads elevations, section and details for HVAC and plumbing.
10. Details for equipment or system supports with seismic bracing.
11. Design of Fire Protection Systems including but not limited to head and piping layout. Design system with the required flow rate utilizing the actual measured lowest water pressure.

G. Electrical Drawings

1. Title and Revision blocks.
2. Registration seal (each drawing).
3. Electrical general notes.
4. Legends which include electrical symbols.
5. Abbreviations.
6. Schedules for electrical and lighting.
7. Single line diagram.
8. Electrical Site Plans.
9. Power plans.
10. Lighting plans. Coordinate the lighting layout with the Fire Protection Systems discussed in both the architectural and mechanical drawings requirements.
11. Electrical details such as sound systems, communication systems, fire alarm, security, telecommunications and data processing.
12. Plans for equipment pads and details.
13. Details of electrical equipment and seismic bracing.

2.4.10 TITLE BLOCK:

The title block on each sheet shall contain general information regarding the project, and a descriptive drawing title. The following information is required:

1. The number of each sheet by dicipline.
2. A descriptive title and location of the project.
3. DFCM Project Number.
4. Signature and date of Record Drawings.

SECTION 2.4 DRAFTING

2.4.10 TITLE BLOCK: (Continued):

5. Scale for drawings unless noted otherwise.
6. Name, address and phone for the fee Architect/Engineer.
7. Initials of drafts person, design engineer or job captain and project manager (if applicable).
8. Initial of principal checker.
9. Dates of issuance and dates of any revisions.

2.4.11 Revision Block

The revision block on each sheet shall contain the following information:

1. Revision number column.
2. By whom (initials) column.
3. Date column.
4. Description column.

All revisions on the Contract Documents shall be accomplished using the delta symbol placed adjacent to the revised element with the most current revision number. The portion revised shall be circled or ballooned on the drawing encompassing the delta symbol. Only the most current revision shall have the circled area depicted. Previous revision delta symbols shall remain, but the balloon line shall be erased. If an entire drawing is revised or a new drawing is added to the set, place the revision mark close to the drawing title block and circle the mark. Include in revision block description column references to Change Order numbers with dates.

2.4.12 PROCESSES AND TECHNIQUES WHICH ARE NOT ACCEPTABLE ON THE RECORD DRAWINGS FOR DFCM's ARCHIVES.

1. Transfer type letters and symbols.
2. Details and notes applied with adhesives.
3. Exception: Small decals with project name or A/E firm are acceptable in the title block, and decals furnished by DFCM.
4. Drawings made of different drawing sheet media and taped together.
5. Tapes of transfer type letters applied with adhesives.

SECTION 2.4 DRAFTING

2.4.13 Computer-Aided Design/Drafting (CADD)

DFCM encourages the use of this new concept in drafting provided the following aspects are incorporated into the drawings. The Architect shall provide CADD Record Drawings for any project:

1. That drafting requirements discussed in these criteria be incorporated in the drawing presentation. The A/E shall submit CADD examples to DFCM's Project Coordinator prior to preparation of the Contract Documents.
2. The examples and the final CADD drawings shall be 100% compatible with DFCM's system. Call DFCM's Facilities Management Section for current information.
3. That the A/E's software/hardware be capable of plotting on polyester film 3 mil thickness (min.), full size drafting sheets either 24" x 36" or 30" x 42".
4. That the A/E's selection of graphics and abbreviations be in conformance with nationally known publications like those found in the "Architectural Graphic Standards", the "American National Standards Institute (ANSI)", Military Standards, National Associations and Institutes.
5. The graphics plotter shall be capable of plotting linework and lettering with differing line weights to depict the differences between boundary conditions, dimensions, existing or new construction, etc.
6. Shading and other graphic depictions shall not obscure the drawing intent to convey construction details and dimensions.
7. Lettering legibility and symbols shall be in accordance with these drafting criteria assuming that in the future the drawings may be reduced to half size or microfilmed.
8. The plotter shall be capable of plotting linework for sloping surfaces with a smooth continuous depiction.
9. Small drawings prepared by the plotter representing sections, details, legends, etc., and taped onto the mylar drawing sheet will not be allowed.

SECTION 2.4 DRAFTING (CONTINUED)

10. The A/E must coordinate the CADD documents to standardize the graphic depictions with Architectural, Landscape Architectural, Civil, Structural, Mechanical and Electrical as to scale, style and format.
11. Computer-aided Design/Drafting legends with item numbers and references to project specifications shall be of sufficient definition for drawing checking, review and material identification.

SECTION 2.5 SPECIFICATIONS

2.5.1 For all DFCM projects, a broad scope specification shall be used as a minimum. Short form specifications will not be allowed regardless of the size of the project. The specification shall be carefully edited to convey the necessary requirements for each project discipline. All irrelevant items shall be removed. Those sections that need information added for clarity or special requirements shall be revised to conform with project requirements.

2.5.2 The specification for all disciplines shall use the MASTERFORMAT (CSI Document MP-2-1) Section numbering system as published by the Construction Specifications Institute (CSI). MASTERPSPEC format is also acceptable.

2.5.3 The architect/engineer shall address the following items in the specification where applicable:

A. Have all warranties, guaranties and certificates listed immediately after the Table of Contents.
B. Have the time of completion and the liquidated damages filled in on the Contract Form.
C. List applicable codes from DFCM's Design Decal appearing on the Title Sheet of the Contract Drawings.
D. List at least three (3) manufacturers (model numbers/type) for all building materials. No listing of an individual manufacturer shall imply a sole-source. The Architect/Engineer shall verify that all manufacturers' products listed have similar performance properties and dimensions where possible. A single manufacturer's name should be avoided as well as the phrase "or equal". See Section 2.2.
E. Include a copy of the Soils Investigation Report in the Appendix of the specification.

SECTION 2.5 SPECIFIFCATIONS

2.5.3 (Continued)

F. Coordinate all notes on the drawings with the project specification in content and terminology before submitting Contract Documents to DFCM for review. Particular emphasis should be placed on coordinating Structural General Notes on the drawings with the project specification Division headings: Site Work, Concrete, Masonry, Metals, Wood and Plastics and Special Construction.

G. Each individual section of the specification shall be presented in the traditional three part format. Part 1 - GENERAL, Part 2 - PRODUCTS, Part 3 - EXECUTION.

H. Considering the ease of specification modification afforded by electronic word processing, it is recommended that A/E firms develop a "DFCM" oriented specification for use when designing state owned facilities. "Lessons learned" during DFCM reviews should be retained for future DFCM projects.

I. All non-pertinent information shall be removed from the specifications. "Master" specifications must be edited to reflect project under design.

J. Do not use lump sum allowances in any specification section as a contingency fund for errors or omissions.

SECTION 2.6 VALUE ENGINEERING

2.6.1 Design Topics That Affect Energy Consumption and Maintenance

The following list of topics by discipline has been prepared to assist the A/E to design more cost efficient facilities. These topics are often overlooked in the project design process and represent lessons learned from numerous Value Engineering sessions.

A. Landscape Architecture:
Design grounds, general landscape work and planting when desired against building to avoid building splashing and marking, that would allow for low maintenance and upkeep and facilitates easy snow plowing, piling or removal.

B. Civil & Landscape Architecture:
Avoid retaining walls as much as possible. Use natural grade slopes, berms, etc. to avoid cost impact and improve maintainability.

C. Architecture:
Design exterior wall finishes and details to be responsive to low up-keep and maintenance needs.

D. Civil, Architectural, Mechanical & Electrical:
Locate main electrical service room on the same side of site as service. This room should also be adjacent to the maximum building load point, usually the chiller and pumps, etc. Locate mechanical rooms to take advantage of ductwork and piping proximities to major loads.

Locate main air handling units central to the building area(s) being served to reduce large and/or extensive ductwork runs. This location can result in more smaller air handling units per floor or building. The benefits are lower energy and operating costs, more diversity and flexibility of use vs. some increase in maintenance which can be justified if a preventative maintenance policy is initiated.

E. Civil, Architectural & Mechanical:
Locate main gas, water and sewer connections and rooms on the same side of site as service, preferably close to maximum demand points usually core toilet stacks, kitchen, boiler room and fire protection system.

Avoid deep loading dock or service yards to minimize required drainage/plumbing. Locate on side of building that receives sunlight in winter function to minimize ice build-up.

SECTION 2.6 VALUE ENGINEERING

F. Civil, Architectural & Electrical:
Emergency generator (if required) should be located as close as possible to main electrical equipment service.

G. Architectural, Structural & Mechanical:
Keep building height and volume to workable minimum that reduces cost of enclosures, energy, and weight that is usually more responsive to seismic considerations.

Build slope into roof structure in lieu of built-up insulation to solve roof drainage issues.

H. Architectural, Mechanical & Electrical:
Create "controllable zones" for high energy/heat release equipment to optimize HVAC and electrical requirements.

Consider window shading devices on exterior elevations or glass with a low-shading coefficient subject to sunshine to reduce glare and cooling loads.

I. Architectural & Mechanical:
Carefully review the standards and codes for the minimum recommended HVAC fresh air. There is a point where the requirements impose an unrealistic heating and cooling load on the HVAC equipment together with higher owning and operating costs (LCC). This often occurs in very large open facilities such as, auditoriums, sports arenas, etc. Consider providing gas sensor control of minimum fresh air. Also, provide LCC analysis of heat recovery systems.

Provide doors (with vestibule as appropriate) at main exterior entry traffic points to minimize air in/out of building.

Only provide exterior doors that are essential to the efficient operation of the building. Minimal exterior doors helps HVAC and improves security.

Provide quality windows and avoid operable sash if possible. If operable, sash windows must be used. Consider only a very basic and simple HVAC system to avoid higher unnecessary initial cost implication vs. loss of the HVAC system integrity within the building when windows are left open.

Optimize use of glass and wall insulation to control cost and energy impact with respect to function and directional exposure.

Optimize type and thickness of insulation for building enclosure (roof and walls), piping and ductwork to meet the actual design function and operating temperatures in lieu of "standard" generic specifications.

SECTION 2.6 VALUE ENGINERING

Optimize class and type of construction and/or work design to take full advantage of any fire protection such as a sprinkler system. If classification does not require fire sprinkling, then verify with Risk Management the life cycle cost benefits of a fire sprinkler system.

Building orientation, ratio of quantity of outside wall/roof to useable building space, ratio of useable exterior (outside) building space to interior building space, and volume of the building, all affect the initial cost and greatly influence the building's energy consumption. Seek viable, optimized and justifiable design solution for all trades.

Locate computer rooms away from exterior exposures (walls and other areas) where outside weather conditions can impact on a reasonable stabilized and predictable cooling load year round.

J. Architectural & Electrical

Light harvesting devices usually add cost to a project and the benefits are often offset by higher maintenance costs. Glare may be a problem if building elements are not properly designed and detailed. Light harvesting will likely increase energy costs in the cooling mode.

Locate electrical risers and closets to minimize conduit and wiring runs in building both vertically and horizontally.

K. Mechanical & Electrical

Simplified control systems using DDC systems usually work best and are more likely to remain in use if the operators can understand them. Review preferences with facility maintenance group and DFCM engineering.

Consider variable frequency drives for variable loads only.

L. Structural

Always provide site information and boring logs before design decisions are made for foundations and structural systems. Design the lightest type of structure for the poorest soil conditions.

Investigate type of structural design that may be better to suite remote area locations and construct ability.

SECTION 2.62.4 VALUE ENGINERING

M. Electrical

Lighting loads should be adequate for the intended use and function only. This helps control HVAC loads and energy consumption.

Selective use of exterior space lighting control can be beneficial if justified by cost and energy analysis.

An EMS for example can be beneficial if justified by cost and energy analysis plus operations personnel capability and other buildings interface on campus.

Minimize the use of incandescent or high heat rejection type lighting devices. It usually costs between two, three or more times the initial cost of one light fixture to provide the physical air conditioning equipment needed to offset the heat being rejected into the space by the light fixture. Additionally, more energy is used to achieve an equivalent lighting level and provide cooling to overcome the added heat rejection within the space.

Select appropriate voltage to optimize distribution costs and application for ease of maintenance. (Best for client maintenance capability).

Select lighting fixtures that perform the required function at the lowest cost for quality and value, with respect to acceptable appearance.

Make sure electrical transformer is not too large for the intended function and service.

SECTION 3 ARCHITECTURAL

3.1 GENERAL DESIGN APPROACH

3.1.1 State facilities owned and used for long periods of time (usually 40-100+ years) shall be designed for long term ownership and the lowest total Life Cycle Cost (first cost plus operating cost) as required by Rules and Regulations for State-owned facilities.

3.1.2 State facilities are subject to change in both function and support systems during their life. Flexibility and easy adaption to change are to be incorporated in the design, i.e. space for additional mechanical, electrical, communications and data processing. Also, use a minimum of shear or bearing walls which would disrupt the future additions or adaptations of the building.

3.1.3 If the facility is to be part of a State campus, it must follow the Building Board approved master plan provided by DFCM and shall form an integral part of the continuum of development. If the facility is independent of a campus, it must be compatible within the context of the general surroundings.

3.1.4 All facilities are to be totally designed to acknowledge the project or natural boundaries and include: structures, utilities, parking, landscaping, mechanical, electrical, communications, furnishings (new and existing), signage, etc. per DFCM provided information on existing conditions.

3.2 FACILITY SITING

3.2.1 Facilities shall orient to the site topography. Where possible, main entrance(s) preferably facing to the south first, then east or west - north entrances are to be avoided in areas of freezing.

3.2.2 All occupied spaces are to be located above the flood plain for the specific area including flash flood zones. Provide drainage systems, waterproofing, etc. for all other spaces at or below the high water table or below finished grade including planters.

3.2.2 All facilities should orient to and take advantage of solar orientation, prevailing winds, natural site features, i.e., water, vegetation, geography, topography, etc. for the specific project site.

3.2.4 Provide Fire Department access roads and/or designated paths of required widths capable of supporting fire fighting equipment. Identify locations for fire hydrants.

SECTION 3 ARCHITECTURAL

3.3 LANDSCAPING

3.3.1 All State facilities are to be landscaped and the site developed to the project limit lines or natural boundaries. If a facility is in a natural setting, all construction-damaged areas are to be restored to the extent practicable.

3.3.2 All plants shall conform to USDA zone requirements and be suitable to the local soils. Plants shall be selected according to appropriate solar aspect, exposure and microclimates. When applicable, use principles of xeriscape landscaping in design.

3.3.2 Trees and shrubs should be placed to reduce solar gain in the summer and allow solar gain in the winter. Planting material should also be used as a screening device for parking areas, service yards, transformers, etc. Trees in parking areas shall be selected based on reducing leaf litter and be "sap-drip" free.

3.3.4 Irrigation systems are to be designed for minimum maintenance and maximum water conservation. Rationale for selection of head type and spacing shall be stated on plans with water management strategy.

3.4 MATERIALS

3.4.1 All materials used in State facilities should be durable and low in cost to maintain.

3.4.2 Life Cycle Costing should be applied as a determinant when selecting between material options.

3.4.3 List in most cases three manufacturers for all specified materials and products. See Sections 2.2 and 2.5.

3.5 APPROVAL SHEET

3.5.1 Architect/Engineer shall obtain all required signatures.

3.5.2 Architect/Engineer shall fill out DFCM's Design and Code Criteria Decal on the Title Drawing.

3.6 SPECIFICATION INDEX

3.6.1 Index all Divisions and Sections. See Section 2.5 - Specifications.

3.6.2 List all guarantees, warranties and certificates required from the contractor. See Section 2.5 - Specifications.

SECTION 3 ARCHITECTURAL

3.7 BIDDING REQUIREMENTS AND DOCUMENTS

3.7.1 Bidding Requirements and Documents consists of DFCM Standard forms: (Use most recent edition of forms).

1. Notice to Contractor.
2. Instructions to Bidders.
3. Proposal.
4. Bid Bond.
5. Bidder's Proposed Subcontractors, Suppliers and Vendors List.
6. Contract Form.
7. Payment Bond.
8. Performance Bond.
9. Certificate of Substantial Completion.
10. General Conditions.
11. Supplementary General Conditions (to be added by Architect/Engineer). List applicable codes in the Supplementary General Conditions, as listed on the Design and Code Criteria Decal.

3.7.2 The General Conditions document shall not be changed or modified. If the consultant finds it necessary to clarify particular aspects of the General Conditions or communicate specific job related modifications, the consultant shall incorporate these by a Supplementary General Condition Section if authorized by the Project Coordinator.

3.7.3 Architect/Engineer to fill out the "Notice to Contractors" and the "Contractor's Agreement Form" in consultation with DFCM Project Coordinator and determine the amounts listed below:

1. Number of contract calendar days for the project.
2. Dollar amount of liquidated damages for the project as directed by DFCM.
3. Bid date, time and location of bid opening as scheduled by DFCM's Contract Coordinator.
4. Bidders required contract document deposit.
5. Unless noted in the advertisement, Architect/Engineer shall notify DFCM of all pre-bid mandatory conferences.

3.7.4 Basis of Bid Award:

1. Basis of Bid Award is included in Instructions to Bidders. If the method of Award varies, prior approval must be obtained from the DFCM's Project Coordinator.

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3.8 DIVISION 1 General Requirements

A. ALTERNATES

1. Nothing should be included as an alternate which is an integral part of the project.
2. It is preferred that no alternates be used. If alternates are deemed necessary, discuss need and obtain approval from DFCM's Project Coordinator prior to advertisement.
3. The use of alternates has to be approved in advance by DFCM's Project Coordinator.
4. Only additive alternates may be used.
5. Describe completely all bidding alternates.
6. Base Bid plus Alternates shall not exceed the project construction budget.
7. Alternates are not to be used to increase the scope of the original project. They are only to keep the project within the construction budget. The basis of award of bid is found in the Policy and Procedures Manual.

B. SHUTDOWNS

Include the following information in the Contract Documents:

1. Contractor shall schedule all shut downs (utility and space closure) with the user institution/agency. Coordinate all shut downs to coincide with regular institution/agency down times.
2. Contractor shall notify the user institution/agency and DFCM of all shut downs a minimum of 3 days in advance unless a longer period of time is required by the Agency/Institution.

C. TEMPORARY FACILITIES

Include the following information in the Contract Documents:

1. Temporary heat shall be provided by the contractor.
2. Temporary power shall be provided and metered by the contractor. If power is taken from an institution's system, it must be metered independently by a meter provided by the Contractor.
3. Water shall be provided and metered by the Agency/Institution unless the project is on a new isolated site.
4. The architects shall also address the following in Division 1:
   a. Temporary enclosing, drying out, etc.:
      When openings are made in exterior walls, the contractor shall, if required by the Architect/Engineer on account

of weather or security conditions, close up all exterior openings (except one or more which are to be provided with battened doors, padlocks, etc.) with temporary frames covered with approved material.

The Contractor must, at all times, protect the building from damage from weather, surface water or subsoil drainage. He must keep the excavations dry, if necessary, by pumping, while concrete or masonry is being laid.

b. Examination of the site:

The Contractor shall visit the site of the building and examine for himself the site and soil conditions. He shall furnish all labor and materials necessary for preparation of the site for the execution of this contract.

c. Field Office:

The Contractor shall erect on the premises, where directed, and maintain a temporary, weather tight office. The field office shall be of such size and be equipped with a telephone, suitable lighting and a table or counter space to permit a convenient examination of drawings. Long distance calls shall be paid by the party making call. The office shall remain the property of the Contractor and shall be removed at the completion of the work. The office must accommodate the Architect/Engineer, owners representative, site meetings with heat, plan table, chairs, lights, and telephone. Costs are to be borne by the Contractor.

d. Storage and care of materials:

The Contractor shall provide, maintain and remove when and where directed, suitable, substantial, watertight storage sheds upon the premises, in which he shall store his materials. All cement, lime and other materials affected by moisture shall be covered and protected to keep from damage while it is being transported to the site.

e. Temporary appurtenances and conveniences:

The Contractor shall provide well-fastened ladders and other means to facilitate observation of the work.

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f. Scaffolding, tools, etc.:

The Contractor shall provide and erect all the necessary platforms, scaffolds and supports of ample strength required for the handling of the materials and other loading to be imposed. The same shall apply to all derricks and hoisting machinery, all appliances and materials, ladders, poles, plants, ropes, wedges, centers, etc. and other tools and materials, and the cartage thereof to and from the building as may become necessary for the performance of his contract

g. Sanitary provisions:

The Contractor shall provide a chemical toilet for his workmen's use. The Contractor shall keep the toilet clean, neat and in first-class condition at all times.

h. Refuse:

Refuse barrels are to be provided by the Contractor for the workmen's lunch boxes and papers.

i. Removing Water:

The Contractor shall remove, at his expense from all excavations and/or from the building, all unwanted water appearing from any cause during any stage of the work until the building is accepted by the Owner. All excavations shall be free from water before any concreting or other work is done in them.

j. Cleaning Up:

The contractor shall at all times keep the construction area free from accumulations of debris, waste material and rubbish, maintaining it in a neat and orderly condition throughout the construction period.

At the completion of the work and in preparation for final inspection, he shall remove all scaffolding, tools, rubbish, temporary construction, etc. not a part of the finished project from the site and dispose of it per paragraph.

The contractor shall clean up the project by sweeping, dusting, mopping, polishing, wiping, etc. as required, for all areas of the project as appropriate to remove all dust, stains, dirt, oil, etc. from all interior and exterior surfaces.

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The project shall be turned over to the owner in new condition ready for his use and occupancy without any additional cleaning required.

k. Rubbish Disposal:

Rubbish, trash, etc., shall not be burned on premises unless approved by the local fire authority, but rather, hauled from the site and legally disposed of.

D. PROJECT IDENTIFICATION SIGN

The project identification sign shall be included in the Contract Documents.

1. The sign shall be provided by the contractor and list the following:

   a. Name of the project.
   b. DFCM as owner for the state of Utah.
   c. Architect.
   d. Architect's Consultants.
   e. Contractor.
   f. Mechanical subcontractor.
   g. Electrical subcontractor.

2. No advertising or logo other than the State is permitted.
3. The sign shall be a minimum size of 4' x 8' as approved by DFCM.

E. PROJECT CLOSE OUT

1. See Article 9 in the General Conditions.
2. Owners Storage and Excess Materials

   a. The A/E shall inform the contractor to deliver to the owner's designated representative all specified storage stock and obtain a signed receipt for each type of material.

F. DOCUMENTS

The Architect/Engineer shall administer the following:

1. Record Drawings:
   a. The Architect shall specify in the Contract Documents that a separate set of prints be maintained on site and "red line" updates by the Contractor be kept current.

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b. All prints shall show all construction changes in the drawings and up date "red-lines" at least monthly.
c. All items concealed or buried shall be dimensioned to a permanent structure or reference point.

2. Operation & Maintenance Manuals:

a. Submitted to Architect/Engineer at time of Substantial Completion by the Contractor.
b. Installer shall provide on-site operating instruction by Substantial Completion time, for maintenance or operating personnel before final payment.
c. Submit one copy of O. & M. Manuals to both DFCM and the user agency or institution. Present to DFCM a signed receipt stating the Manuals were submitted to the user agency. Manuals may be submitted and indexed in three ring binders.

3. Guarantees:

a. A Contractor to submit at time of Substantial Completion all required guarantees, warranties, and certificates in writing and sign by the subcontractor and/or general contractor.
b. Roofing guarantees shall be signed by the general contractor, the roofing subcontractor(s) and the manufacturer.

4. Certificate of Substantial Completion Form:

a. The Architect fills out the Certificate of Substantial Completion Form.
b. Certificate of Substantial Completion Form determines the start of the guarantee periods.
c. The date of the Certificate of Substantial Completion Form corresponds to the project "Certificate of Occupancy" date or later as issued by the State Fire Marshal's office.
d. The Certificate of Substantial Completion Form is distributed by DFCM with signatures obtained by the Architect/Engineer.

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5. Certificate of Occupancy:

a. Issued by the State Fire Marshal's Office.
b. Fire Marshal will send a copy to DFCM and one copy to Agency/Institution.

3.9 DIVISION 2 Site Work:

The Architect/Engineer shall specify and administer the following but not limited to:

A. GENERAL

1. Rubbish, demolished material, vegetation, debris, etc. shall be hauled away and disposed of legally off site.
2. Acceptable existing top soil shall be stockpiled and reused in landscape areas. Excess top soil is to be disposed of by the Contractor.
3. Demolition of Existing Facilities:

a. All existing utilities are to be capped, restored, or repaired as required whether shown or not.

4. Use untreated base course under all curbs and gutters.
5. All existing site utility manholes, cleanouts, valve boxes, etc., are to be raised to finish grade. New utility manholes, cleanouts, valve boxes, etc are to be installed at finished grade.
6. The Architect shall specify a dust and erosion control site program in the contract documents.

B. HAZARDOUS MATERIALS

For the Architect/Engineer's information, the following DFCM procedure for hazardous materials abatement is provided:

DFCM will hire an Industrial Hygienist as early as possible during the design process to survey all remodel projects for asbestos and PCB, etc. If hazardous materials are found, DFCM will contract with an abatement contractor to remove the materials before any construction work begins. It will be DFCM's responsibility to procure bids from all approved certified abatement companies. The abatement consultant will prepare all the bidding documents.

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It will be the responsibility of the Architect/Engineer to provide demolition drawings at the design development stage to the owner's Industrial Hygienist. The drawings shall sufficiently describe demolition so that the Industrial Hygienists can survey disturbed materials for hazardous materials. The cost of abatement should be identified as early as practical.

DFCM may require the Architect/Engineer to include a general note on the drawings that DFCM has selective abatement from the demolition area. If any hazardous materials are found or if the general contractor suspects finding hazardous materials during his work, STOP ALL WORK IMMEDIATELY. The general contractor shall call DFCM who in turn will contact the abatement consultants to come in and sample the materials for identification. NO WORK SHOULD CONTINUE UNTIL THE ABATEMENT CONSULTANT HAS CERTIFIED THE AREA TO BE CLEAN OF HAZARDOUS MATERIALS CONTAINING MATERIALS.

C. EARTHWORK

1. Contractor shall submit test reports for review on all import material to Architect/Engineer and DFCM prior to delivery.
2. Topographic surveys are to be considered no more accurate than 1/2 the contour interval.
3. Rough grading shall be within +3" of finish grade specified in the contract documents.
4. Do not use explosives without DFCM approval.
5. Caution contractor to not over excavate. Provide a remedy in the specifications.
6. Cut and fill should be balanced as much as possible.
7. Do not block traffic routes without appropriate authorization.
8. Compaction: (at optimum moisture in the absence of a soil report based on Modified Proctor ASTM D1557):

    a. Unpaved areas: compact to 85% for cohesive soils.
    b. Walkways, against structures and Flat Work: compact to 90% for cohesive soils.
    c. Roads, Curb and Gutter, Pavements & Structures: compact to 95% for cohesive soils.

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d. Compaction testing shall be required for all lifts by an approved testing laboratory as recommended by the Architect or Engineer.
e. Allowable lifts heights:

(1) Hand compactor 6" maximum.
(2) Vibratory roller 12" maximum.

f. Water jetting and/or hydro compaction are not permitted unless approved by soil engineer and DFCM.
g. During the course of construction, protect all soils under structures from frost.

9. Set all grades and lines with surveying instruments.

10. Trenching:

a. Do not backfill trenches until observation, tests and inspections have been made and backfilling authorized by the Architect/Engineer.
b. The Architect/Engineer must reference the UOSHA regarding trenching operations in the Contract Documents.
c. In addition to the backfill requirements, the Architect/Engineer should recognize recommendations by piping or insulating manufacturers regarding pipe bedding and backfill procedures.

D. FILL MATERIALS

1. Submit Modified Proctor tests on all sources of fill material.
2. Specify all bedding and backfill materials and installation procedure for utilities.
3. Use untreated base coarse material under all sidewalks exterior flatwork and paved areas.

E. DEWATERING

1. Keep all water from entering excavations, project site or surrounding area.
2. Keep all excavations dewatered by mechanical or other means at all times.

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3. Place all excess water in a normal storm waterways. Provide a means to control water from all sources during construction.
4. Control all soil erosion by stabilizing slopes and runoff on site.

F. IRRIGATION SYSTEMS

1. Water conservation analysis must be provided.
2. Show location of connection into building service line, water source, pressure at source, pumping where required and electrical service to clocks.
3. Coordinate irrigation system, water, and electrical requirements with electrical, mechanical consultants and landscape architect.
4. Provide friction loss calculations for the two circuits located farthest and highest from the water source.

G. ASPHALT CONCRETE PAVING

For Concrete Pavement, See Structural Section.

1. Use untreated base coarse under all asphalt paving of the following gradation:

SIZE	% BY WEIGHT PAVING SEIVE
1"	"100
1/2"	70 to 100
#4	41 to 68
#16	21 to 41
#50	10 to 27
#200	4 to 13

2. Surface coarse (asphalt) aggregate of the following gradation:

SIZE	% BY WEIGHT PASSING SEIVE
3/4"	100%
3/8"	70 to 100
#4	50 to 78
#16	30 to 48
#50	18 to 31
#200	7 to 13

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3. Construct (lay) asphalt (paving) concrete surface only when atmospheric temperature is above 50oF and underlying base is free from moisture.
4. Permit no vehicular traffic for at least 24 hours after laying asphalt pavements.
5. Striping Paint: State of Utah #780: Spread at the rate of 103-113 Sq. Ft./Gal. Minimum thickness shall be 7 dry mil.
6. Tack coat all adjoining materials, i.e. previously constructed asphalt, concrete, etc. except untreated base coarse.
7. Surface smoothness: Variation in the finished surface must not exceed 1/8" in 10 Ft. in any direction.
8. Asphalt shall comply with Marshal Design with voids 1.5% to 3.0%.
9. Drainage: Slope all asphalt concrete paving surfaces for positive drainage a minimum of 1.5% preferably 2%.
10. Minimum thickness for parking areas is 2 1/2". Minimum thickness for road areas and truck traffic is 3" including dumpster access.

H. PLANTING

1. Submit certified existing soils nutrient and suitability analysis by an independent testing laboratory.
2. Submit certified nutrient and suitability analysis on soil to be imported by an independent testing laboratory.

   a. Acceptable soils must test to the following tolerances:

ph = 5.5 – 7.8	% Org. Matter	> 2.2
Soluble Salts = < 2.0	% Sand	50-55
SAR = < 3.0 (Sodium Absorption Rate)	% Silt	25-35
	% Clay	15-20

3. Plans must reflect the size of plants at maturity, spacing them accordingly.
4. Specify varieties readily available through local sources. When specifying a variety not readily available through local sources, note on plant schedule where it may be obtained and a point of contact.
5. SOD is preferred over seeding lawns. Seed only on flat areas and when grown-in, can be completed prior to project date of Substantial Completion.

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3.10 DIVISION 3 Concrete

See Structural Section for Additional Information.

A. CONCRETE MIX

1. Use low alkali cement for all concrete in direct contact with earth.

B. PROPERTIES

1. Strength: 3000 psi minimum for footings and foundation. 4000 psi minimum for all weather exposed or flatwork concrete.
2. Air Content: 6 1/2% + 1 1/2% for all exterior concrete.

C. CURING COMPOUNDS OR MOISTURE RETAINING MATERIAL

1. Use on all exterior concrete.
2. Fugitive dye shall be required in all curing compounds.

D. ADMIXTURES

1. Do not use calcium chloride for any reason.

E. FORMWORK

1. Use only new and undamaged formwork material on exposed to view concrete.

2. Do not use wire ties or ties fabricated on the project site.

3. All concrete work shall be formed to the given dimensions, line and grade.

F. REINFORCING

1. Supports: Use only bolsters, chairs, and spacers manufactured specifically for this purpose. Do not use wood, brick, etc.

2. Reinforcing: Use only material manufactured specifically for concrete reinforcing. Use coated reinforcing bars for weather exposed supported slabs, ramps, etc.

3. Reinforcing shall be continuous through all joints unless allowed by the structural engineer.

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G. TESTING

1. All concrete testing shall be performed by an approved DFCM testing laboratory as recommended by the project Architect or Engineer from DFCM's approved list of testing laboratories.
2. Testing shall be paid for by DFCM unless other agency procedures are specified. Retesting shall be paid for by contractor if test results do not meet or exceed specifications.
3. Testing shall be called for by the contractor by notifying the testing laboratory at least 24 hours before the pour.

H. PLACEMENT

1. Do not place unprotected concrete when ambient temperature is 400F and falling.
2. Hot or cold weather placement shall be per ACI Handbook.
3. Do not allow concrete aggregate and slurry to separate or to free fall into forms.
4. Architect/Engineer shall observe architectural formwork and reinforcement prior to placement of concrete.

I. JOINTS

1. Slabs on grade shall have a joint 15'-0" or less in each direction.
2. Control joints shall be slab depth divided by 4 minimum either sawn or tooled. All tool joints should be 1/4" maximum radius. Width of all joints shall not exceed 1/4".

J. GUARANTEE:

1. Provide two-year written guarantee in form approved by Architect/Engineer to promptly remove and/or repair defective concrete (pitting, spalling, cracking, honeycombing, etc.) as directed by Architect/Engineer and at Contractor's expense. New replacement work shall carry a similar new two-year written guarantee. Guarantee shall start from Date of Substantial Completion. This guarantee shall be stated in Part One - General, Division 03300 of the specifications.

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3.11 DIVISION 4 Masonry

Refer to the Structural Section for additional criteria regarding normal and special observation.

A. GENERAL

1. Combine unreinforced masonry and reinforced masonry section in the specifications.

2. Coordinate general notes on drawings with masonry specification.

3. Grout: Use 2000 psi minimum per ASTM C476 and C404 unless a special condition requires otherwise.
   Comply with Chapter 24 of U.B.C.
   Slump 8" - 10".
   Low lift - 4 Ft. max.
   High lift - clean outs at bottom of wall required. High lift grouting requires DFCM approval prior to or at Design Development Phase.

4. Concrete block:
   ASTM C90, N-1
   Normal weight (light weight for special cases)
   Core must have 4" x 4" horizontal plan dimension minimum.

5. Mortar:
   Aggregates for masonry mortar shall be per C144.
   Use type "S" 1800 psi minimum per C150 and C270 (not C91 Masonry Cement) as standard.
   Use type "M" 2500 psi is special applications.
   Type "N" 750 psi is not allowed for reinforced masonry.
   Use C207 type "S" hydrated lime.

6. Unreinforced masonry except non-structural veneer is not allowed.

7. Honed block is not allowed in external applications.

8. Face brick use:
   ASTM C216 Type, FBX or FBS Grade, SW.
   Do not use grade MW.
   Exposed ends and faces shall have the same texture.

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B. ATLAS BRICK USE:

Hollow:
1. ASTM C652 Grade SW., with C652 tolerances. Type selected by Architect.

Solid:
1. ASTM C216 Grade SW., with C216 tolerances. Type selected Architect.

C. REINFORCING

1. Horizontal

a. Use ladder type not truss type with vertical reinforcing.

b. For total percentage of steel reinforcement, see Chapter 24 of the Uniform Building Code.

c. Use preformed corners and "T" intersection lapped 6" - 8" (9 gauge - 3/16" diameter wire).

d. Hot dip galvanized wire reinforcement after fabrication. Joint side rod reinforcement shall preferably be deformed.

e. Install grouted bond beams at 4'-O" O.C. and reinforce with (2) #4 rebar's minimum.

2. Vertical

a. Splice: 40 bar diameters minimum for rebar.
b. Spacing: #5 minimum at 32" O.C. unless governed by other structural requirements.
c. Foundation doweling into the CMU wall shall be at an increment of the spacing of the vertical steel.

D. ANCHORS

1. Brick veneer attached to concrete must have dovetail anchors that have a 3/16" long, 90 degree bend of 16 gauge galvanized material. The hook shall engage the horizontal joint reinforcement.

2. Install galvanized slots in concrete.

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3.12 DIVISION 5 Structural Steel

A. GENERAL

1. Welding shall conform to the provisions of the American Welding Society's AWS D1.1 "Structural Welding Code" (latest edition) for welding in building construction.
2. All welding shall be done by a certified welder per AWS D1.1 within the last 12 months.
3. Nuts shall be tightened per one of the five (5) AISC methods of tightening. Load indicator washer or load indicator bolt method is recommended.
4. All painting and shop priming shall be with non-lead paint.
   Painted Steel: Zinc - chromate, alkali type TT-P-645, except for galvanizing touch-up type TT-P-641 2 mil minimum thickness.

B. METAL DECKING

1. Galvanized decking is required below grade and at other locations subjected to moisture or high humidity. Exposed to view decking is preferred to be painted.

C. MISCELLANEOUS METAL:

1. All exterior work shall be galvanized. Utilize ASTM A123 for galvanizing rolled, pressed and forged steel shapes, plates, bars and strips 1/8" thick and heavier. Utilize ASTM A 386 for galvanizing assembled steel products.
2. Painted Steel: Zinc - chromate, alkali type TT-P-645, except for galvanizing touch-up type TT-P-641 2 mil minimum thickness.

3.13 DIVISION 6 Wood and Plastic

A. GENERAL

1. Coordinate this section with structural notes relating to wood members.
2. Use the Western Lumber Grading Rules (WWPA) not the UBC.
3. Douglas fir or larch is normally used for studs. Specify stud grade or better. Studs wider than 5" shall be No. 2 or better.

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4. Use hem-fir for treated plates No. 2 or better.

   a. CCAC treated 0.25 lbs/cubic ft.5.Comply with Table 25-Q in the UBC for nailing.

5. For Fire-Retardant Treatment, comply with AWPA standards for pressure impregnation with fire - retardant chemicals to achieve a flame grade rating not to exceed 25 tested in accordance with UL Test 723 ASTM E-84 or NFPA test 355.

6. For Sheathing - use plywood APA grade trademarked.

   a. Oriented strand board may be used for sheathing (not wafer board).

7. The Architectural Woodwork Section shall include the names of 3 mills which are satisfactory to DFCM and the Architect. All other mills must have prior written approval before bidding from both DFCM and the Architect.

8. Plastic laminate must be manufactured by Formica, Nevamar or Wilson-art unless another manufacturer is approved by DFCM.

3.14 DIVISION 7 Thermal and Moisture Protection

A. GENERAL

1. Minimum guarantee period for labor and materials that applies to both new construction and reroofing:

   a. Sealant: Sealant systems shall be guaranteed for 2 years minimum.

   b. Roofing: Fifteen (15) years manufacturers' warranty for single ply and 20 years for built-up systems.

2. Design and application of all roofing/waterproofing and sheet metal work shall conform (at the time of installation) to or exceed requirements applicable sections of the Uniform Building Code - current adopted edition; National Roofing Contractors Association Roofing and Waterproofing Manual - current edition; Sheet Metal & Air Conditioning Contractors National Association Architectural Sheet Metal Manual - current edition; primary roofing manufacturer's current requirements for their standard 20-year labor and materials No-Dollar Limit warranty; and the contract documents; when there is a discrepancy, the most stringent and explicit requirements apply as interpreted by DFCM.

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3. Thermal protection shall comply with the ASHRAE STD No. 90.1 (latest edition as adopted).

4. Single ply, built-up and modified bitumen roofing systems shall have a minimum rating of Factory Mutuals' FM I-90. Single ply ballasted systems (minimum ballast weight of 13 PSF) and other systems as described above shall have gravel properly sized and placed to withstand the blow-off and uplift forces generated by the highest governing wind velocity. Mechanically fastened and fully adhered systems must have anchors that extend through and attached the entire roofing system into the structure (in structural decking). This FM I-90 rating shall mean the entire roofing system shall sustain 45 psf uplift.

5. Fire Rating for Roofing Systems:

   a. All roofing systems shall be designed to conform to a tested UL Class A rating and where feasible shall be designed as a tested UL Class A assembly (roof system and structure).

   b. Gypsum board shall not be installed immediately under roofing to achieve a system fire-rating.

   c. Gypsum sheathing is an acceptable product to achieve a fire rating when used in a UL Class A tested roof system or assembly.

6. Wind criteria for roofing systems is found in the Structural Section.

7. Roof Slope Requirements:

   a. Minimum slope for all roofing and waterproofing systems shall be a 1/4" per foot along the longest drainage path.

   b. Each new building project shall be evaluated to determine the most cost effective method for achieving the 1/4 inch per foot slope (tapered insulation or sloping of the deck).

   c. Each existing building project shall be evaluated to determine existing roof slope and if additional slope is needed as defined in the Uniform Building Code to eliminate ponding.

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8. Seismic Requirements for Existing Roof Decks:

   a. All existing roof deck structures should be evaluated by a Certified Structural Engineer specializing in seismic structural analysis to determine the need for upgrading the diaphragm to meet current seismic requirements.
   b. A report shall be prepared that outlines the following:

      (1) Existing conditions relative to current requirements.

      (2) Recommendations for upgrading the diaphragm, relative to an upgrade of the building.

      (3) Estimated costs for upgrading the diaphragm.

9. Asbestos Containing Roofing and Waterproofing Materials:

   a. Use of asbestos containing materials on State projects is prohibited.
   b. Removal and abatements procedures.

      (1) See Section 3.9 B Hazardous Materials.

10. Contractor Guarantee for Roofing and Waterproofing Projects.

   a. A minimum two (2) year labor and materials guarantee for all state roofing work shall be provided by all primary contractors, sub-contractors or sub-sub-contractors, on the DFCM Roofing Contractor Guarantee Form.
   b. A minimum five (5) year labor and materials guarantee for all state waterproofing work shall be provided by all primary contractors, sub-contractors or sub-sub contractors, on the DFCM Roofing Contractor Guarantee Form.

11. Manufacturer Warranties for roofing and waterproofing Materials Projects.

   a. Available no-cost materials warranties shall be provided for all roofing and waterproofing materials used on State projects.

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12. Roofing Contractor Qualification:

a. General:

(1) Company installing specified roofing systems/materials for a minimum of five (5) years.
(2) Company approved by primary roofing materials manufacturer for a minimum of two (2) years.
(3) Foreman installing specified roofing systems/materials for a minimum of five (5) years.

b. Licensing requirements:

(1) Company must hold a current contractors license for the city, county and State of Utah.
(2) Contractors license classification must be for the specific type of roofing/waterproofing work performed.

13. Roofing Manufacturer Prequalification.

a. General:

(1) Producing materials for a minimum of five (5) years.

b. Product performance:

(1) No product with documented failure will be allowed.

14. Hazardous Roofing or Waterproofing Materials.

a. Roofing or waterproofing materials that pose a significant health or environmental threat shall not be used on state projects.

b. Roofing or waterproofing materials on existing buildings that are found to pose a significant health or environmental threat shall be properly abated in accordance with current local, state and federal guidelines. See Section 3.9 B Hazardous Materials.

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15. Roof Load Requirements (See Section 4.5.3.A for additional information).

    a. The weight of the entire roof system on new construction shall not exceed an amount that would reduce the live load capacity of the roof structure below the current requirements.

    b. Existing structures

        (1) All existing roof deck structures including unheated roof systems should be evaluated by a structural engineer to determine the existing dead and live load capacity.

        (2) The weight of the entire roof system shall not exceed an amount that would reduce the live load capacity of the roof structure below the current requirements, or

        (3) The weight of the entire roofing system shall be the minimum possible to maximize the live load capacity of the roof structure.

        (4) The evaluation should determine if snow drifiting is a problem with regard to the designed live load, including the effect of added insulation on additional snow load.

    c. A report shall be prepared that outlines the following:

        (1) The existing conditions relative to current requirements.

        (2) Recommendations for upgrading the load capacity, relative to an upgrade of the building.

        (3) Estimated costs for upgrading the structure.

16. Provide Ventilation Requirements as outlined in the Uniform Building Code in:

    a. Attic, ceiling and joist spaces.

17. Verify the roof deck and roofing system are compatible.

18. Follow current manufacturer's published recommendations and published industry standards for expansion joints and area dividers.

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19. Verify that the roofing systems comply with fire criteria found in the UBC and UL (See Section 3.14A.5).

20. Include recommended testing in the roofing specification.

    a. Type of testing.
    b. Frequency.
    c. Type of testing agency - who will conduct tests.
    d. Corrective work required if tests fail.
    e. What costs are borne by whom.

21. Roof System Determination:

    a. Designer must evalaute at least three (3) roof membranes/systems for suitability and cost on each project.

    b. Designer must evaluate the feasibility of using existing insulation, sheet metal and other existing roof system components if they are in like-new condition or will not have a deleterious affect on the new roof system.

22. Damp Proofing

    a. Select three (3) products based on suitability for specific use. If one product is specified, provide justification for selection including the following:

        (1) Successfully producing materials for a minimum of fifteen (15) years.

    b. Product performance:

        (1) Successful use for a minimum of fifteen (15) years.

23. Determine the need for vapor retarder based on dew point calculations, building use, and existing building and roofing system conditions.

24. Evaluate cost of use of tapered insulation versus sloping the structure.

25. Where there is a choice of roofing systems, select system based on a 20-year life cycle costing.

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26. Waterproofing:

a. Select three (3) products based on suitability for specific use. If one product is selected, provide justification for selection, including the following:

(1) Successfully producing materials for a minimum of fifteen (15) years.

b. Product performance:

(1) Successful use for a minimum of (15) years.

3.15 DIVISION 8 Doors and Windows

A. GENERAL

1. Guarantee all thermal glazing for five years minimum including all labor and materials.

2. Wind loading for Glass, Doors, Window Frames and etc.: See Structural Section.

3. Hollow metal frames 16 gage minimum (welded frames preferred).

4. Grout full all hollow metal frames in masonry and provide 20 gage stainless steel guards for lock strikes.

5. Install rubber silencers on all non-gasketed frames.

6. All wood doors (slabs) are to be solid core (do not specify hollow core doors).

7. Roll down doors and fire shutter must be equipped with a roll down governor to prevent hazardous rapid closure. Roll down fire shutters should not be used if another option is available.

8. All hardware shall be commercial grade or better. DFCM requires that architects specify lever-type hardware in new and and totally remodeled buildings where circumstances allow. Designers must take into account issues such as security, partial remodeling, or building use which may not allow lever-type hardware utilization.

9. All swing doors shall have 3 hinges minimum.

SECTION 3 ARCHITECTURAL

3.15(7) Special Roll Down Door Guidelines: The following guidelines shall be used for Special Roll Down Doors, in addition to meeting the requirements of the UBC for egrees:

a. Doors must be motorized.
b. Doors must have a controlled reate of decent so as not to be a hazard.
c. Doors must be easily reset after fire alarm release without mechanically resetting door closing mechanism under normal conditions.
d. Door must be a listed 20-munite or greater, automatic closing, fire assembly with adequate smoke gasketing.
e. Door must be provided with protection from release by momentary power interruption.

SECTION 3 ARCHITECTURAL

3.16 DIVISION 9 Finishes

A. CARPET:

1. Use of the State Contract for carpet or carpet tiles is recommended where applicable or feasible. Selected manufacturers and installers are listed in the current Statewide contract.
2. The State Contract indicates applicable use for each type carpet. Cost and vendor contact, with all terms, are listed in the Contract. Selection and application of carpet for each use is the responsibility of the architect. Carpets in the contract have been selected to meet heavy duty commercial applications. Review any proposed variances with Project Coordinator
3. State Contract Carpet will be an owner furnished item but cost must be included in the project budget.
4. Specify in contract documents general contractor shall coordinate installation of carpet with all other trades, as part of his contract.

B. STORAGE STOCK

1. Five (5%) minimum of installed area for all items such as acoustical tile, floor tile, carpet tile, carpet, etc. in unopened containers and no remnants. Provide storage stock space in the facility.

C. GYPSUM BOARD

1. Specify all applications and types of gypsum board, trim items, and include manufacturer's model numbers.
2. Use cement board in wet areas.
3. Specify tapered edges on all gypsum board to be taped.

D. PAINT PRIMER

1. Use zinc chromate as ferrous metal primer (do not use lead based primer.

E. PAINT FINISHED COAT

1. Use alkyd enamel as finish coat on all appropriate surfaces with manufacturers recommended sealants and primers. Do not use water based latex paint.

F. TILE

1. Use full set ceramic tile only.
2. Seal all ceramic tile grout.

SECTION 3 ARCHITECTURAL

3.17 DIVISION 10 Specialties

A. Toilet Compartments

1. Metal toilet partitions and divisions shall use the following minimum gages of steel.

Panels:	20 gage
Doors:	20 gage
Pilasters:	16 gage
Finish:	Baked enamel or better

B. DISPENSERS

1. Coordinate with agency or institution. Agencies and institutions generally buy toilet paper and towels, etc. on state contract. These contracts provide the dispensers.

2. All facilities not served by a State contract require dispensers to be provided.

3.18 DIVISION 11 Equipment (none)

3.19 DIVISION 12 Furnishings

MOVEABLE FURNISHINGS

A. The overall project should be reviewed by the designer in terms of the program requirements, budgets, and other criteria. The selection of furnishings and design of layouts are to be project specific. Prior to the completion of the design to appropriately fit furnishings into the project, the designer shall obtain a current list of available products on Statewide Contract and Utah Correctional Industries (UCI) from DFCM's Accounting Technician responsible for procurement.

B. Furnishings and installation including, but not necessarily limited to, office furniture (chairs, tables, bookcases, etc.), open office furnishings (metal or wood), systems furnishings and demountable partitions, such as the brand/trade name Herman Miller are not part of the basic construction Contract Documents. Furnishings as listed above are budgeted separately. Consequently, separate and distinct specification and installation contracts are required and must be reviewed and approved by DFCM and if not on statewide contract or available through UCI, should be processed by DFCM through the Division of Purchasing, unless the Agency or

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Institution is authorized in writing by DFCM to handle the procurement under a force account.

C. The Utah Procurement Code regarding furnishings source selection states all public procurement agencies shall purchase goods and services from statewide contracts or produced by the Utah Correctional Industries Division. This should be done where the products are appropriate to the furnishings design. The Division of State Purchasing and Correctional Industries publish and distribute to all State agencies yearly catalogs or lists of goods and services provided by them. These references should be consulted for appropriate products.

D. State agencies, departments and institutions should not purchase any goods or services provided by statewide contracts or Correctional Industries Division from another source unless it has been determined in writing by the Director of said agency and the State procurement officer or the institutional procurement officer that purchase from statewide contracts or the Correctional Industries Division is not feasible due to one of the following circumstances:

1. The goods or services offered by the state contracts or UCI do not meet the reasonable requirements of the design;

2. The goods or services cannot be supplied within a reasonable time, or

3. The cost of the goods or services, including basic price, transportation costs and other expenses of acquisition, is not competitive with the cost of procuring the items from another source.

3.20 DIVISION 13 Special Construction

A. FIRE SUPPRESSION SYSTEMS

1. Coordinate the layout and installation of all fire suppression systems with all other systems in the project (Mechanical, Electrical and Architectural).

B. PRE-ENGINEERED BUILDINGS

1. Pre-engineered Buildings: See Structural Section.

2. Pre design approval required from DFCM for this type construction.

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3.21 DIVISION 14 Conveying Systems

A. ELEVATORS

1. Use hydraulic elevators in buildings of 2 or 3 stories.

2. For other elevator design criteria, see Structural Section.

3.22 DIVISION 15 Mechanical

A. MISCELLANEOUS:

1. Do not locate any exhaust that will reach any mechanical intake systems. Avoid short circuiting of exhaust and supply.

2. Coordinate painting of mechanical equipment with Division 9 and Division 15.

~~MODEL ENERGY CODE COMPLIANCE FORMS & INSTRUCTIONS~~

~~STATE OF UTAH DEPARTMENT OF ADMINISTRATIVE SERVICES DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT~~

~~SECTION 3 ARCHITECTURAL~~

~~3-30~~

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4.1 Code Compliance: The purpose of a code is to safeguard life, health and property through adoption of minimum design and construction criteria. Enforcement of codes is the responsibility of the Building Official. DFCM requires the plans, calculations, and specifications to be prepared by a currently licensed architect or engineer in the State of Utah.

Before the project bid date can be set, DFCM will review and approve contract documents as the Building Official.

4.2 Structural Review: The structural review at DFCM is accomplished within the context of the word "review." DFCM does not go through calculations step by step. The review will:

A. Make sure proper codes, design loads and allowable stresses and/or load factors have been utilized.

B. Verify that load paths and design concepts are rational.

C. Randomly check to verify a detailed code compliance.

D. Select critical structural elements for independent computations to verify design.

E. Review connection details and the layout of reinforcing steel or framing in critical locations.

F. Compare structural notes with the project specifications for coordination.

4.3 Construction Observation: To verify that a building or structure is constructed to meet Code and DFCM Criteria, an organized field quality control program is necessary. This begins with an adequate set of construction documents which are clear and complete and includes construction observation.

Codes universally require that the construction work be at least periodically observed. The professional services agreement with DFCM will require this basic observation. Complex projects may require the need to retain (by DFCM) special inspectors. DFCM may hire and authorize the Architect/Engineer to perform special inspection as more commonly known here as "extended observation." In any case the special inspector will be hired by DFCM and be responsible to the same. Requirements for observations, special inspection and testing are noted further in this section.

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4.4 General: These criteria represents information and the minimum basis of design for structural. Acting as a supplement to the basic building codes previously mentioned, the intent will be to improve design concepts and details which provide ductility, continuity and redundancy. Nonredundant structures should be designed and detailed with a full understanding of their performance and constructed with special care in accordance with the contract documents.

The size and complexity of the subject precludes a perfect set of criteria or an absolute fixed approach to the practice of structural engineering. However, with the support of the structural engineering community, associations and a broader understanding by the general public these criteria can become a useful tool to improve structural engineering practice and building quality by:

A. Clarifying the scope and character of structural engineering services to reduce structural failures or poor performances.

B. Requiring a more profound interaction between the architect and engineer.

C. Sharpening the perception of the engineer's assignment.

D. Integrating the results from Life Cycle/Value Engineering.

E. Minimizing or eliminating litigation between the owner, architect, engineer or contractor due to properly defining the scope of work in the contract documents.

With these goals in mind, recognition is also given to the fact that structural engineering practices (experiences and office design philosophy) varies from office to office. The minimum basis of design to be described attempts to standardize the scope of the minimum assignment that shall be provided by the Architect/Engineer.

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4.5 Minimum Basis of Design for Structural:

4.5.1 Wind Velocity: The applicable Uniform Building Code shall apply except as noted below:

A. All new and remodeled facilities north of Salt Lake City excluding Cache County shall utilize a minimum wind velocity of 90 miles per hour unless known local wind anomalies would prevail.

B. The minimum exposure shall be "B".

C. Single Ply Ballasted Roof: See Article Section 4.5.3 for ballast weight.

D. Eastern Canyon Winds: One form of topographic winds which can create serious problems are the so-called "Easterly Canyon Winds". These winds occur primarily along the Wasatch Front when a strong high pressure system develops over southern Wyoming and a low pressure system over Nevada or extreme southwestern Utah. When a surface pressure gradient between Lander and Salt Lake City exceeds five to seven millibars and a supporting northeasterly flow at about 10,000 feet occurs, winds in excess of 75 miles per hour can occur in Cache, Weber, Davis and Salt Lake Counties. In early April 1983 winds in excess of 100 miles per hour caused many million of dollars damage to power lines, transportation (both rail and highway) and to homes in these counties.

E. Record Winds: There are very few weather stations in Utah that keep winds information. Thus data on winds are not nearly as available as other weather variables. The highest recorded wind gust in the state of 115 miles per hour occurred on June 9, 1978 at Francis Peak near Farmington. The highest gust for a bench location was recorded in Bountiful on November 11, 1978 at 110 miles per hour. A valley location with the highest wind gust was recorded on June 3, 1963 at the Salt Lake Airport at 94 miles per hour. These high speed winds are usually short lived and sustained high winds are rare.

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4.5.2 Seismicity: Incorporate the U.B.C. seismic requirements except where:

A. Doubt exists as to whether a facility is in, for example, zone 2 or 3, in which case, the higher seismic zone shall be used.

B. An Occupancy Category designated by DFCM (Owner) as an Essential Facility, Hazardous Facility or Special Occupancy Structure, the Owner may request the Geotechnical Engineer to provide a site specific frequency and ground acceleration values. The Architect/Engineer shall incorporate these values into the design. See Chapter 23 of the U.B.C. for definition of Occupancy Requirements and assigned Importance Factors.

C. A building or structure with a U.B.C. primary Occupancy Category classified as an Essential Facility, Hazardous Facility or Special Occupancy Structure such as medical facilities, emergency communication centers, emergency vehicle shelters and garages, schools, libraries, offices, jails, and detention facilities shall incorporate the following fraction of the roof design snow load (Cs) into the roofs total dead load for seismic analysis:

Cs = 0.25 + 0.025 (A-5)

where

Cs = fraction of design snow load to be used in seismic lateral force calculations, and

A = elevation above sea level (ft./1000).

Exception: Covered structures whose primary Occupancy Category is public assembly with a capacity greater than 300 persons shall incorporate an importance factor equal to 1.25 in addition to the snow plus drift load in the roofs total dead load for seismic analysis.

The design of seismic-resistant structures is more than applying seismic forces to a mathematical model. It requires a knowledge of the nature of earthquakes, ground motion they cause and an understanding of the inelastic performance of structures, as members will exceed yield in any significant earthquake. It also involves ones experience of conceiving a system and its proportions and

details such that the structure can perform inelastically with controlled deformations to limit damage and protect occupants. The layout of bracing, moment frame or shear wall systems shall be defined as follows:

A. Must have sufficient stiffness to control drift.

B. Preferably continuous throughout the height of the building.

C. Should avoid abrupt changes or discontinuities in stiffness which will attract considerable dynamic amplifications in strong ground shaking.

D. Should minimize torsional response of the structure by avoiding concentration and unbalance of stiffness.

Where possible, the Architect/Engineer should consider utilizing redundant structural systems to additionally minimize the aformentioned performance problems.

Often, DFCM in the normal plan review process has commented on the previous guidelines as a goal this Division would desire in all structures. But some Architect/Engineers have suggested that these restrictions stifle their creative design. But DFCM feels restrictions are important. Education, a proper concept and careful execution can produce a truly creative expression of a modern structure within these restrictions.

4.5.3 Roof Loads: The following loads, unless known otherwise or noted in the U.B.C. shall be incorporated in all roof structures:

A. Loads:

1. Dead Load: The weight of the entire roof system.

   a. Single-Ply Roof Ballast: The minimum ballast weight shall be 13 psf over the entire roof. Some manufacturers of single-ply ballasted roofs may require ballast weight in excess of 13 PSF.
   b. Skylight Framing: Design skylight framing to support the roof's snow plus drift load or live load whichever is greater plus a concentrated load of 300 lb at mid-span on each member.

2. Live Load: Minimum 20 PSF.

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3. Ground Snow Load: Sets of SCS (Soil Conservation Service) snow course and NWS National Weather Service) weather station data have been plotted for all of the Utah's counties. Ground snow in psf was plotted versus site elevation in ft. These sets of data were fitted utilizing the following empirical equation:

   $Pg = (Po^2 + S^2(A-Ao)^2)^{1/2}$ for $A > Ao$ Eq. 4-1

   and

   $Pg = Po$ for $A < Ao$

   where

   Pg = ground snow at a given elevation (psf),
   Po = ground snow at the valley floor (psf),
   S = change in ground snow with elevation (psf/1000 ft.),
   A = elevation above sea level (ft./1000), and
   Ao = asymptote and zero ground snow axis intercept (ft./1000)

   Enclosed Fig. 4.1 shows a schematic plot of Eq. 4-1. Values of Po, S, and Ao representing approximate upper bounds to the data in the twenty-nine county plots are given in Table 4-1. As an example, suppose that one desire the ground snow load for an elevation of 5300 ft. in the Salt Lake Valley. Substitution of the appropirate values from Table 4-1 of Po = 43, S = 63, and Ao = 5.3 in Eq. 4-1 results in a ground snow of 66 psf. Multiplying the 0.7 normal exposure Ce factor from the U.B.C. (Appendix, Chapter 23, Division I), one obtains a design roof snow load of 46 psf.

   Enclosed Table 4-2 provides base ground snow and roof design snow values for the lower elevations of selected Utah communities as rcommended by the technical committee of the SEAU (Structural Engineers Association of Utah).

   It should be recognized that there are local factors which could affect the ground snow, Pg, for a particular snow course, weather station, or building site such as:

   a. Longitude of the site (successive mountain ranges),
   b. Latitude of the site,

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c. Windward vs. leeward side of a given mountain range,
d. Proximity of lakes windward of the site, and
e. Exposure of the site to wind and sun.

These factors can significantly modify (often decrease) the value of the intercept, Ao and, consequently, the ground snow, Pg. Designers interested in such factors may desire to investigate the ground snow values of snow courses closest to the given site. Site exposure influences are provided for by the exposure factor Ce given in U.B.C. Appendix 23, Div. 1. Other important design factors should be considered include drifting, warm vs. cold roofs, ice damming, snow sliding from an upper to a lower roof, etc.

The minimum design roof snow load shall be 20 PSF.

4. Snow Drift: U.B.C Appendix Chapter 23, Div. I.

B. Roof Slope: The minimum roof slope shall be 1/4" per foot along the longest drainage path. This requirement is based on two important aspects. First, certain areas of the roof may be subjected to uneven or unbalanced snow load, causing the location of maximum bending to shift, hence affecting the roof deflection. Secondly, recent Energy Codes have required a more efficient thermal insulation barrier, hence hendering melting.

C. Roof Framing: Coupled with the roof slope design criteria is the common practice of using open web joists or trusses to support the roof loads. These framing elements are most sensitive to unbalanced snow loads and subsequent deflections. Hence, the following criteria shall apply to these elements:

1. Open Web Members: In most cases, the consultant may select these element sizes from vendor catalogs. In cases where the structural span exceeds 140 feet and/or a Special Occupancy Category exists, DFCM may require the Architect/Engineer to custom design all framing elements.
2. Wood Joists and Open Web Members: The 15 percent increase in allowable stresses for short duration snow loads should generally not be used for elevations above 5000 ft. above sea level.

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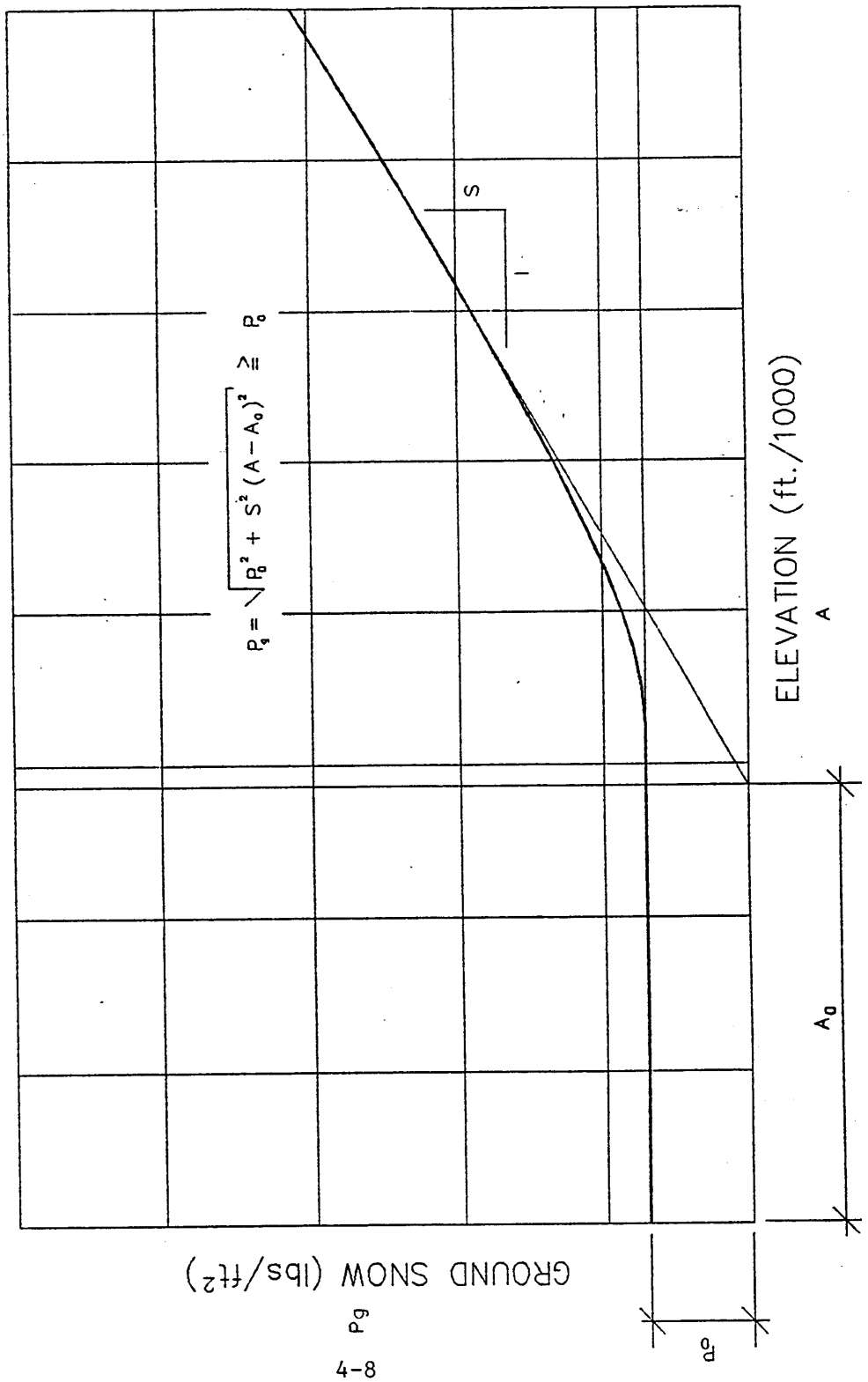

Fig. 4 GROUND SNOW V. ELEVATION

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TABLE 4-1

GROUND SNOW PARAMETERS

COUNTY	Po (PSF)	S (PSF/1000 FT.)	Ao (FT./1000)
Beaver	71	63	6.2
Box Elder	43	63	5.2
Cache	50	63	4.5
Carbon	43	63	5.2
Daggett	43	63	6.5
Davis	43	63	4.5
Duchesne	43	63	6.5
Emery	43	63	6.0
Garfield	43	63	6.0
Grand	36	63	6.5
Iron	43	63	5.8
Juab	43	63	5.2
Kane	36	63	5.7
Millard	43	63	5.3
Morgan	57	63	4.5
Piute	43	63	6.2
Rich	57	63	4.1
Salt Lake	43	63	4.5
San Juan	43	63	6.5
Sanpete	43	63	5.2
Sevier	43	63	6.0
Summit	86	63	5.0
Tooele	43	63	4.5
Uintah	43	63	7.0
Utah	43	63	4.5
Wasatch	86	63	5.0
Washington	29	63	6.0
Wayne	36	63	6.5
Weber	43	63	4.5

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TABLE NO. 4-2

RECOMMENDED BASE SNOW LOADS FOR SELECTED UTAH CITIES AND TOWNS*

County	Elevation Feet	Design Load (PSF)	Ground Load (PSF)
Beaver County			
Beaver	5920	50	71
Box Elder County			
Brigham City	4300	30	43
Tremonton	4322	30	43
Cache County			
Logan	4530	35	50
Smithfield	4200	35	50
Carbon County			
Price	5600	30	43
Daggett County			
Manilla	5377	30	43
Davis County			
Bountiful	4300	30	43
Farmington	4270	30	43
Layton	4400	30	43
Fruit Heights	4500	40	57
Duchesne County			
Duchesne	5510	30	43
Roosevelt	5104	30	43
Emery County			
Castledale	5660	30	43
Green River	4070	25	36
Garfield County			
Panguitch	6600	30	43
Grand County			
Moab	3965	25	36
Iron County			
Cedar City	5831	30	43

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County	Elevation Feet	Design Load (PSF)	Ground Load (PSF)
Juab County			
Nephi	5130	30	43
Kane County			
Kanab	5000	25	36
Millard County			
Millard	5000	30	43
Delta	4623	30	43
Morgan County			
Morgan	5064	40	57
Piute County			
Piute	5996	30	43
Rich County			
Woodruff	6315	40	57
Salt Lake County			
Murray	4300	30	43
Salt Lake City	4330	30	43
Sandy	4500	30	43
West Jordan	4200	30	43
West Valley	4500	30	43
San Juan County			
Blanding	6200	30	43
Monticello	6820	35	50
Sanpete County			
Fairview	6750	35	50
Mt. Pleasant	5900	30	43
Manti	5740	30	43
Ephraim	5540	30	43
Gunnison	5145	30	43
Sevier County			
Salina	5130	30	43
Richfield	5270	30	43
Summit County			
Coalville	5600	60	86
Kamas	6500	70	100
Park City	6400	85	121
Summit Park	7200	90	128

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County	Elevation Feet	Design Load (PSF)	Ground Load (PSF)
Tooele County			
Tooele	5100	30	43
Uintah County			
Vernal	5280	30	43
Utah County			
American Fork	4500	30	43
Orem	4650	30	43
Pleasant Grove	5000	30	43
Provo	5000	30	43
Spanish Fork	4720	30	43
Wasatch County			
Heber	5630	60	86
Washington County			
Central	5209	25	36
Dameron	4550	25	36
Leeds	3460	20	29
Rockville	3700	25	36
Santa Clara	2850	15*	21
St. George	2750	15*	21
Wayne County			
Loa	7080	30	43
Hanksville	4308	25	36
Weber County			
North Ogden	4500	40	57
Ogden	4350	30	43

* See Article 4.5.3 (A) for minimum snow load.

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4.5.4 Floor Loading: The provisions of Chapter 23 of the Uniform Building Code for uniform and concentrated floor loadings shall apply for all State facilities except for the following:

A. Load Revision: When an institution or State agency requests a uniform and/or concentrated load that differs from those magnitude stated in the U.B.C., those loads shall be incorporated by the consultant into the design. In no case, should the revised loads be less than those stated nor produce stresses less than what may be anticipated from incorporating those uniform and/or concentrated loads from the U.B.C.

B. Floor Live Load: Due to the nature of State business where there is a need for many filing cabinets, open office landscaping, etc., all floors shall be designed for a minimum of 80 psf uniform load plus 20 psf for removeable partitions. The provisions of a 2000 lb concentrated load placed upon any space 2 1/2 feet square in lieu of the uniform live load still applies. When the U.B.C. Table in Chapter 23 for uniform and concentrated loads require loads in excess of those magnitudes previously stated, the larger load requirement shall prevail.

In addition to the uniform live load change, is the requirement that no live load reduction will be allowed in the design of floor beams, trusses, joists, floor slabs, decking, composite framing or miscellaneous framing. Live load reduction, however, will be allowed in the design of columns and bearing walls. These provisions are intended to minimize floor deflections.

4.5.5 Geotechnical Reports: The Architect/Engineer shall incorporate all the applicable aspects of the geotechnical report into the project. Furnished by the Owner(DFCM), the Architect/Engineer shall coordinate their efforts to accurately convey this information into the project specifications, drawing details, sections and structural general notes. Every effort should be made to utilize consistent industry recognized terminology throughout all documents. See the DFCM CADD Criteria for specifications.

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The Architect/Engineer shall bind the Geotechnical Report in the Appendix of the project specifications. Boring logs should not be extracted from the report and placed in the drawing package. This past practice has led contractors to draw conclusions without understanding the written portions of the report.

4.5.6 Cement Types: One of the important design parameters furnished by the Owner via the Geotechnical Report is the type of cement to use. DFCM has traditionally used three(3) types of cement, namely: Type I or Type II (both low alkali) and Type V. In all cases the cement type to specify will be one of these types. In most cases for southern Utah, Type V. will be specified. The remaining portions of the State will normally be specified as Type I or II (low alkali).

Air-entrained concrete should specify the admixture requirements of ASTM C260. The cement type designation of "IA", "IIA", etc., should not be used on State projects. The specifications shall address the content of air in the mix. DFCM recognizes the following air contents as sufficient for concrete in direct contact with the soils or exposed to severe salting:

Max. Aggregrate Size per C33	Air Content per C260
3/4"	6 1/2%+ 1 1/2%
1"	6% + 1 1/2%
1 1/2"	5 1/2%+ 1%

All exterior concrete shall be air-entrained with percentages of air and aggregate size specified in the project specifications. Water/cement ratios shall be quoted in the specifications utilizing those values in ACI 318. The number of bags of cement per/yard in accordance with C150 shall be given. Finally the specifications should state the cement shall be from one source to control color where final finish is visible.

4.5.7 Concrete Strengths & Testing: DFCM continues to require the following compressive strengths at 28 days; namely, 3000 psi for foundations stem walls, piers, miscellaneous interior pads, etc., and 4000 psi for all exterior flatwork, ramps, curbs, gutters, catch basins, concrete pavements, interior floor slabs, elevated slabs, shear walls and columns. Shear walls may be specified in excess of 4000 psi. Occasionally, columns may be specified as 5000 psi. All pre-cast concrete panels shall have a strength of 5000 psi.

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The majority of concrete will generally be classified as normal weight. Elevated floor and roof slabs occasionally are light weight concrete. If an element is designated to be constructed of light weight concrete, the light weight concrete shall weigh a minimum of 90 lb/ft3.

All concrete shall be reinforced with conventional rebar or welded wire fabric where appropriate. Slabs on grade not required to support more than 400 lb/ft2 may be unreinforced if the sub-base is uniformly compacted with on-site observation to the requirements specified in the project specifications.

Concrete testing shall be deemed adequate if at least three(3) standard cylinders are taken by the testing agency per 50 cubic yards or each day's pour. The Architect/Engineer shall recommend a testing agency from the Owner's list of approved laboratories. The testing agency shall cast the cylinders and transport them to the laboratory for testing. The Contractor shall cure the cylinders on the job site.

4.5.8 Masonry: The use of masonry continues to be one of the more important building materials that lends itself to architectural diversity. Chapters 24 and 30 of the U.B.C. will continue to be the basic standards for all masonry construction except for the following:

A. Both low and high lift grouting construction are allowed. DFCM prefers the Architect/Engineer to specify in the Contract Documents the selected method of grouting for reasons of budgeting and bidding purposes. Refer to the DFCM CADD Criteria.

B. Bond beams shall be incorporated in all construction at a maximum spacing of 4'-0 cc. Provide reinforcement in accordance with UBC.

C. Joint reinforcement may be included in the wall design, but this reinforcement shall not replace the requirement for reinforced bond beams at the given spacing.

D. Ladder type joint reinforcement shall be the configuration that is best suitable for placement of all reinforcement.

E. All embedments in masonry shall be secured with hooked anchor bolts conforming to the requirements of ASTM A307. Deformed bar anchors (DBA's) or HSA may also be specified.

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F. All mortar shall be type "S" or "M" and have a minimum strength of 1800 psi and 2500 psi, respectively. Proportions shall be in accordance with Chapter 24 of the UBC.

G. All grout shall have a minimum strength of 2000 psi in accordance with Chapter 24 of the UBC.

H. Ledger angles with anchor bolts shall not be used to support primary roof or floor framing.

I. Attachment of structural elements to existing hollow cell masonry shall not incorporate toggle type bolting, but rather anchored into grouted cells.

J. Where special inspection is requested by the Architect/Engineer, those walls requiring special inspection shall be so noted on the drawings.

K. All wood plates in contact with masonry shall either be foundation grade redwood or treated hem-fir lumber.

L. Maximum center to center spacing of shrinkage control joints shall not exceed 50 feet. Expansion joints shall be designed to consider movement of all interfacing materials.

M. Reinforcement that requires welding shall be of the deformed bar anchor type and conform to ASTM A496.

N. Footing stem walls to finish grade or floor shall preferably not be constructed of masonry.

O. Honed masonry should not be incorporated in walls exposed to weather due to the difficulty in waterproofing.

P. Embedded or bearing steel plates supporting primary structural framing shall be a minimum of 1/2" thick.

Q. Foundation dowels into the supported masonry wall shall be spaced an increment or match of the vertical masonry reinforcement.

R. Internal non-load bearing walls may be supported on thickened floor slabs at Architect/Engineer option.

S. In addition to the veneer requirements of the U.B.C., the following additional requirements shall apply:

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1. Brick veneer shall have #9 galvanized wire gauge in bed joints spaced 16" O.C.
2. Brick veneer attached to metal studs should be a two-piece #9 gauge adjustable galvanized tie which engages the #9 wire gauge in the bed joints.
3. Brick veneer attached to concrete must have dovetail anchors that have a 3/16" long, 90 degree bend of 16 gauge galvanized material.
4. All anchors and lintels supporting veneer shall be galvanized.
5. When the masonry or stone veneer back-up system is constructed of gypsum sheathing on metal studs, the entire back-up system shall be "x" braced with galvanized sheet metal straps (minimum 14 gauge) installed by weldments or cadmium plated screws with washers per manufacturer's recommendations. In addition, the gypsum sheathing shall be covered with a minimum 15 lb felt.
6. Masonry or stone veneer clad curtain walls should be supported on the elevated floor slabs and not attached to the perimeter edge embedments with tack weldments.

4.5.9 Elevators: All newly installed traction or hydraulic personnel elevators shall be in accordance with the seismic provisions of Appendix "F" of the Safety Code for Elevators and Escalators, ANSI/ASME A17.1-(Latest Edition) with all supplements. One of the provisions of this Appendix is that standard weight elevator guide rails shall have a lateral back-up system (i.e. floor or beams) at a maximum clear height 12'-6. Elevator shaft framing may act as the back-up system to the guide rails provided:

A. The shaft is constructed of continuous reinforced masonry or concrete.

B. The framing immediately behind the guide rails and bracket supports shall be of structural stud or heavier classification. This requirement implies that typical 20 gauge metal studs for framing the shaft cannot be the back-up system to the guide rails or brackets. In addition, the guide rail weight selected may require installation of spreader bars between the rails to hold the vertical alignment of the system during a seismic event.

All elevator pits shall be constructed with a floor drain connected to a piped system. Access to the pit shall be accomplished with a permanently attached ladder conforming to UOSHA.

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4.5.10 Roof and Floor Diaphragms: All metal decking selected to resist lateral forces from wind or seismic activity shall have the following minimum properties, namely:

A. Gauge: 22 ga.
Coating: G-60 galvanized - (G-90 is preferred)
Attachment: and all welded to structural framing. Attachment of end and side seams shall utilize either top or side seam weldments.

Roof Decking shall be galvanized. Decking used for floor form with concrete fill may be galvanized. The consultant shall specify the minimum sectional properties, i.e. moment of inertia, section modulus and decking depth.

4.5.11 Pre-Engineered Buildings: DFCM has used pre-engineered buildings for maintenance facilities, storage space, parking canopies and sheds where occupancy has been low. It has not been DFCM's policy to strictly utilize a catalog cut of the pre-engineered building, but to enhance certain structural properties to afford added reliability. Our direction to the Architect/Engineer team has been to utilize both the AISC and Metal Building Manufacturer's Association (MBMA) design recommendations.

The basic approach to this assignment has been for the Architect/Engineer to provide via DFCM the minimum basis of design for the building and subsequently designing a foundation system to resist those derived reactions. DFCM has directed the Architect/Engineer to incorporate the load combinations in Chapter 23 of the U.B.C. The Architect/Engineer has then generated a foundation plan with dimensions and sizes including the sizes of anchor bolts required to secure the primary framing to the foundation system. See the DFCM CADD Criteria for specifications on dimensioning. If during the course of finalizing the design of the facility, the pre-engineered building manufacturer derived reactions that varied by more than 5% of what was originally used, DFCM has required the consultants to revise their design to suit the new conditions. Generally, this effort has been a minor undertaking wherein anchor bolt sizes were changed or foundations were slightly modified.

The minimum required loads are as noted in these criteria. Requirements for loads (bridge cranes, equipment supports) not noted in this criteria may be required in addition to wind load, snow load, etc. to meet the program requirements.

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The minimum physical properties of structural components to be incorporated in the contract documents shall be as follows:

A. All primary and end wall wind columns shall be secured to the foundations with minimum 3/4" diameter anchors bolts that are hooked.

B. All build-up "I" shapes or open web rigid frames consisting of tapered or parallel flanges, columns or beams shall have continuous weldments. The minimum web and flange thickness shall be 1/4" and 5/16", respectively.

C. Wind bracing shall consist of adjustable threaded steel rods, 5/8" diameter minimum or equivalent angles or tees. Siding and roofing materials shall not be used to resist lateral forces. Provide gusset or web stiffener plates at end connections. The Architect/Engineer shall incorporate hairpins in the floor slab at each primary rigid frame that hook around the anchor bolt pattern.

D. Secondary framing (purlins, eave struts, end wall beams, columns, etc.) shall be minimum 14 ga. rolled or formed sections. Base channel, sill angle, purlin spacers shall be a minimum of 14 ga. also.

E. Purlin and girt sag rods shall be provided and not spaced over 10'-0 cc. Rods shall be 1/2" diameter minimum and fastened with nuts and washers.

F. All bolting shall be a minimum of 5/8" diameter. Primary framing shall be attached with ASTM A325 or A490 bolting whereas other framing may utilize A307 material. Nuts shall be of the heavy hex type. Hole size for high strength bolting shall be drilled 1/16" larger than the required bolt size. Holes for all other bolting (A307) may be either 1/16" larger than the bolt size or short or long slotted holes. If short or long slotted holes are utilized, however, washers shall be installed under both the bolt head and nut. All bolting shall be tightened in accordance with AISC guidelines. All bolting shall be zinc or cadmium plated.

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G. Connections except for lacing, sag rods, girts and purlins shall be designed to support not less than 6 kips. All connections shall incorporate a minimum of two(2) bolts at each end if mechanically fastened. Rolled angles shall be a minimum of 1/4" thick. Minimum size angles that are mechanically fastened to other members shall be 2 1/2" x 2 1/2" x 1/4".

H. Roof and wall panels shall be minimum of 24 ga (galvanized with G-90 coating) and have a yield strength of at least 50,000 psi.

I. Lite panels shall have the same load requirements as the roof, plus support a concentrated load of a minimum of 300 pounds at mid span.

J. If the structure or building is required to house a bridge crane, or jib crane, the the pre-engineer building manufacturer shall design and size all support framing including rail sizes in accordance with the AISC. The Architect/Engineer shall provide adequate dimensions and elevations on the drawing for bidding purposes including but not limited to hook height, rail support beam elevations, distance between rails, etc. See the DFCM CADD Criteria for detailed specifications on dimensions and elevation.

4.5.12 Slabs on Grade: Large-area concrete floors for commercial or industrial facilities shall be designed and constructed with the greatest possible economy. Floor slabs shall be trouble free regardless whether they are exposed to heavy loads, wet conditions, chemical attack or simply covered with high quality finished flooring. Floors have traditionally been given the least attention by all concerned.

Portland Cement Association has published several articles on the subject over the years addressing those issues that produce a slab with quality performance. Basically, PCA summarizes seven (7) important factors, namely:

- Uniform subgrade compaction of adequate bearing capacity.
- Quality of the concrete.
- Structural capacity.
- Joint spacing.
- Workmanship.

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- Surface finish.

- Future maintenance.

Specific information in regard to each item above can be found in numerous publications available to the consultants. Complementary aspects to these important factors, however, are what DFCM's perceives to be good industry wide accepted practice wherein the Architect/Engineer should incorporate the following:

A. All concrete equipment pads, pedestals and column supports should be set a minimum of 3" above the finished floor slab where wet conditions exist.

B. All floor slabs 4" thick on grade supporting more than 400 lbs. per sq. ft. live load found in office facilities and light industry environments with a compressive strength of 4000 psi and flexural strength of 480-640 psi shall be reinforced with welded wire fabric 6 x 6 - W1.4 x W1.4 as a minimum at slab mid-depth. Thicker slabs shall be reinforced appropriately per ACI 318. DFCM does not recognize the addition of synthetic mesh or polypropylene fibers as a substitute for conventional welded wire fabric, rebar nor improved mix workability.

C. Concrete landings and aprons subject to heavy highway vehicle loadings that may be found as approaches to entry doors, ramps, etc. shall be a minimum of 4000 psi compressive strength, 6" thick and reinforced with #4 @ 12" E.W. at slab mid-depth. Apron edges should be thickened.

D. The preparation of the slab's sub-base and materials shall be as required in the Geotechnical Report furnished by DFCM.

E. If the Architect/Engineer or Geotechnical Report requires a vapor retarder to be installed under the slab, the slab shall be underlain with 2" of sand first followed by the vapor retarder. This requirement is a PCA recommendation.

F. In wet indoor environments, the floor slab shall be sloped to central drains. Both the high and low point slab elevations shall be given on the drawings.

G. Trench drains shall be covered with appropriate cast iron grates to suit required loading. Other large drainage collection covers should be galvanized grating. Steel embedments required to support grating should be galvanized.

H. Concrete pavements for parking lots and walks may be unreinforced but shall conform to the requirements of PCA's recommendations. Concrete parking lots shall be sloped a minimum of 1% for drainage.

I. Slab or pavement control joints shall be installed a minimum 1/4 the slab depth by either sawing or use of a pull-out pre-moulded joint filler system.

J. The Architect/Engineer shall locate construction, control and contraction joints on all flatwork. Joints should preferably be located to form square patterns. Joints should not be further apart than 15' regardless of slab thickness. Reinforcement shall be continuous through all construction joints.

K. Interior isolation joints shall be installed around all columns and perimeter foundation walls. The joint around columns should be a maximum width of 1/2" filled with a composition joint filler. The joint between the slab and perimeter wall need only be a bond breaker system with a 15# felt installed to full slab depth. Exterior flat work where it abuts a structure, i.e., foundation, catch basin, shall be separated with a composition joint filler 3/8" maximum thick.

L. Where extremely caustic or corrosive environments exist, the slab should be reinforced with epoxy coated or galvanized reinforcements.

M. The Architect/Engineer has the option to require the pour of large slab areas in either a checkerboard pattern or lane fashion to control cracking.

N. The requirements for slab strength, air-entrainment, aggregate size, etc. are found elsewhere in these criteria.

4.5.13 Steel Columns. The majority of columns are generally steel pipe, structural tubing and wide flange shapes. Most Architect/Engineers specify ASTM A36 schedule 40 for steel pipe and wide flange columns and ASTM A500 grade B for structural tubing. Frequently, DFCM in the course of

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reviewing the structural notes on the drawings and specifications, has commented on the Architect/Engineer specifying ASTM A501 structural tubing as an alternative to ASTM A500. It is DFCM's understanding that A501 is not readily available and should not be specified. As an alternative to the A36 steel pipe, the Architect/Engineer could specify ASTM A53 types E and S grade B, schedule 40.

In utilizing pipe or tubing for structural columns, the Architect/Engineer should incorporate the following recommended practices to lessen column failures:

A. All bearing brackets supporting roof and floor beams or joists shall have their webs completed slotted through the column and welded.

B. All gusset plates securing and transferring bracing reactions into the columns shall be slotted completely through the column and welded.

C. Column cap plate thickness should be a minimum thickness of 1/2" when supporting steel to steel systems.

D. Column base plate thickness should preferably be not less than 3/4" thick.

E. Plates acting as stabilizing elements to the bottom chords of open web members (joists and joist girders) need not be completely slotted through the pipe or tube column unless the joist member is transferring axial forces into or through the columns.

F. Pipe and structural tube columns that are butt welded shall utilize full penetration weldments with internal backing bars.

G. Wide-flange columns that are butt welded shall utilize either single bevel weldments with backing bars or double bevel weldments. Partial penetration welds for column splices are not acceptable.

H. Column splice location whether bolted or welded should be positioned approximately 3-4' above the floor elevation for ease of installation.

I. Anchor bolt holes in the column base plate should be sized 1/4" larger than the bolt diameter to allow for column positioning. If the anchor bolts are intended to be welded to the base plate, the holes should be sized 1/16" larger than the bolt diameter.

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J. All base plates shall be supported on 3/4-1" of high strength non-shrink, non-metallic grout for leveling purposes.

K. All base plate shims shall be fabricated from steel materials.

L. Anchor bolt projection above the top of concrete to secure base plates shall be grout thickness + base plate thickness + 1.5 x bolt diameter. This requirement will allow for sufficient bolt extension beyond the securing nut.

4.5.14 Concrete Columns. Concrete columns whether circular, square or rectangular should have a minimum compressive strength f'c at 28 days of al least 4000 psi. Sized in accordance with the requirements of ACI 318 and Chapter 26 of the U.B.C., the column reinforcement (longitudinal bars) located within the ties shall not be less than 0.01 nor more than 0.08 times the net area of the concrete section. Other design parameters as follows should be incorporated into the design, namely:

A. Column ties shall not be smaller than #3 bars.
B. Concrete cover shall be the greater thickness of meeting either the requirements of the ACI 318 or the applicable fire code.
C. Circular column longitudinal reinforcement should incorporate a minimum of five (5) bars sized appropriately per Code.
D. Square and rectangular columns shall incorporate a minimum of four (4) longitudinal bars.

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4.6 Observations:

4.6.1 Construction Quality Control:

A. Observation and Testing: The following pages list normal construction observation duties which DFCM expects as a part of an Architect/Engineer (A/E) Agreement, where they apply. Observations by the A/E made on a periodic basis satisfy the requirements of normal observations. Also included are a list of special observations and testing requirements for various types of construction. Special observations and testing are to be coordinated by the A/E. Independent testing agencies as paid for by the owner shall be recommended by the A/E to DFCM to perform the required services. All observations and testing services are intended to assist in the determination of compliance of the work with contract documents.

The requirements of this section relate primarily to customized or job fabrication and installation procedures, not to standard manufactured products. Services include reports for special inspections and tests and related actions performed by independent testing laboratories.

Specific quality control requirements for various categories of work are outlined in these criteria and are to be considered in the appropriate sections of the specifications and, perhaps, on drawings where appropriate.

Observations, tests and related actions specified in these criteria and elsewhere in the contract documents are not intended to limit the Contractor's quality control procedures which facilitate his overall compliance with requirements of the contract documents. See the DFCM CADD Criteria for requirements on documents.

4.6.2 Responsibilities:

A. Owner Responsibilities: Costs for normal observation duties are a part of the A/E Agreement. Costs for special inspections and test will be paid for directly by the Owner and are not to be included in the Construction Contract Sum.

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B. A/E Responsibilities: Independent testing agencies shall be recommended by the A/E and approved by the Owner. The testing agency shall provide certification to the A/E and owner for all technicians to cover the type of work to be performed. Where the project requires some special inspection services, the A/E shall recommend the individual and/or testing agency to perform the duties listed in these criteria. Special inspectors and testing laboratories shall be under the direction of the A/E, but approval of the extent and cost for their work shall remain with the Owner.

C. Retest Responsibility: Where results of special inspection, tests or similar services do not indicate compliance of related work with the requirements of the contract documents, then retests are the responsibility of the Contractor, regardless of whether the original test was the Contractor's responsibility. All discrepancies shall be brought to the immediate attention of the contractor. Provide a written report for all work observed.

D. Coordination: The Contractor and each independent testing agency engaged to perform observations, tests and similar services for the project shall be required to coordinate the sequence of their activities so as to accommodate required services without delay in the progress of the work. In addition the Contractor and each independent testing agency shall coordinate their work so as to eliminate the necessity of removing and replacing work to accommodate observations and tests. The Contractor is responsible for scheduling times for observations, tests, taking of samples and similar activities.

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4.6.3 Concrete: (N = Normal; S= Special; A/E = Architect/Engineer; TA = Testing Agency)

ITEM	DUTIES AND RESPONSIBILITIES	A/E N	A/E S	TA
1.	Familiarize oneself with plans, specifications, shop drawings and applicable sections of referenced codes.	*		
2.	Verify conformance of materials and rebar grade/tendons to project specifications. These duties should include verifying mill markings, tags, cement mill reports, etc.		*	
3.	Observe the installation of studs, bolts and placing of concrete around such embedments when stress increase is permitted per U.B.C.		*	
4.	Review test reports performed under fabricator's quality control program.		*	
5.	Observe the placement of reinforcement, tendons, and pre-stressing steel prior to and during placement of concrete. Observe reinforcement and embedments for ductile moment-resisting frames as stated in the specifications.		*	
6.	Observe the taking of test specimens in accordance with ASTM standards, but need not be present during the taking of all test specimens.	*		
7.	Prior to pours at the job site, verify that the mix design and mixing materials on the concrete delivery tickets are in accordance with the intended use stated in the project specifications.			*
8.	Review reports from testing and inspection agencies to determine if the agency has verified conformance of the reported item of work with the structural contract documents.	*		
9.	Observe mixing, placement and finishing of reinforced concrete including gypsum or insulating concrete as stated in the specifications.		*	

ITEM	DUTIES AND RESPONSIBILITIES	A/E N	A/E S	TA
10.	Check caisson and pier reinforcing, quantity and location prior to pouring of concrete as stated in the specifications.		*	
11.	Review the joint and curing materials used at the job site are in compliance with the project specifications.	*		
12.	Sample materials for test from jobsite supplies when required by specifications.			*
13.	Sample concrete for slump and air content, and have the concrete aggregates, cement type, specialized steels and concrete cylinders delivered to the laboratory for testing.			*
14.	Inspect bathing and mixing plants and equipment for conformance to ASTM or other standards when specified in the specifications.			*
15.	Check and record concrete and air temperatures, length of time since batching, conveyance methods, and verify that they prevent segregation, free fall limit, contaminants in mixture, or additional water.			*
16.	Observe placement of concrete for drilled foundation piers and caissons, per requirements of Chapter 29 of the Uniform Building Code and per foundation investigation recommendations.			*

4.6.4 Masonry: (N = Normal; S = Special; A/E = Architect/Engineer; TA = Testing Agency)

ITEM	DUTIES AND RESPONSIBILITIES	A/E N	A/E S	TA
1.	Review plans, shop drawings and specifications with the masonry contractor in a pre-construction meeting to verify the masonry construction requirements.	*		
2.	Check that masonry construction materials are supported and covered to protect from weather moisture or drying.	*		
3.	Verify size and spacing of reinforcements prior to placement of grout. Verify acceptable concrete surface to receive masonry. Periodically, A/E should check for wall plumbness and layout.	*		
4.	Check for proper mortar ingredients and batching techniques.			*
5.	Verify specified mortar time on board is in accordance with specifications.			*
6.	Periodically check that head joints are the full thickness of face shells and that head joints are used.	*		
7.	Check whether joints are tooled as specified.	*		
8.	Check required number of masonry wall prisms and observe construction of same.			*
9.	Check for ties when specified.	*		
10.	Observe locations of reinforcing steel prior to pouring grout.	*		
11.	Verify that dowels, anchor bolts and inserts are in place prior to pouring grout.	*		
12.	Check grout, mortar mix and admixture required.			*
13.	Check grout space prior to grouting when needed.	*		

14. Check grout space during grouting operations and cleanouts in the first course of each pour if high lift grout is approved.		*		
15. Check that grout is stopped below top masonry course for keying where required.		*		
16. Verify rodding or vibrating during placement and 15 to 20 minutes later to reconsolidate.		*		
17. Verify the bar cover meets the required minimum.	*			
18. Check and record temperature for hot and cold weather construction.			*	
19. Prepare material samples in field for testing:				
a. Masonry units			*	
b. Mortar				
c. Grout				
20. Deliver material samples including masonry prisms to laboratory for testing. Test materials in accordance with the standards referenced in the project specifications and verify conformance with same.			*	
21. Conduct nondestructive testing and/or destructive testing (core drilling, etc.) in accordance with the specifications and as directed.			*	
22. Check mortar and grout aggregates in accordance with specifications.			*	
23. Check slump per specification.			*	

4.6.5 Steel: (N = Normal; S = Special; A/E = Architect/Engineer; TA = Testing Agency)

ITEM DUTIES AND RESPONSIBILITIES	A/E N	A/E S	TA
1. Review place, specifications and shop drawings.	*		
2. Observe that general requirements of referenced codes, particularly the American Welding Society Structural Welding Code (AWS D1.1) and the Manual and Specifications of the American Institute of Steel Construction with Commentary are not violated	*		
3. Review welder qualifications when other than standard AWS joints and procedures are involved.			*
4. During steel erection, verify that mill test reports are submitted for all steel. Verify that proper electrode numbers are to be used.	*		
5. Verify that proper identification of steel is maintained during fabrication. Approve straightening and bending procedures.			*
6. Approve cut edges, including those flame cut, sheared or milled.			*
7. Check bolt holes in primary framing connections for size.		*	
8. Discuss welding sequence for specific joints with steel contractor and testing agency to minimize distortion			*
9. Discuss the adequate steps to be taken to prevent moisture penetration at welding location during adverse weather conditions.			*
10. Discuss specified procedure for tensioning of bolts.	*		
11. Verify that each testing agency nondestructive test technician does work only as covered by his certifications.		*	
12. Verify proper foundation steel piling type and size prior to driving.	*		

SECTION 5 MECHANICAL DESIGN CRITERIA (DIVISION 15)

15010 BASIC MECHANICAL REQUIREMENTS

A. GENERAL

1. These criteria are intended to be a guideline and a standard for mechanical systems design. These design criteria do not in any way relieve the engineer of record of design liability. These criteria are not intended to limit the design options available to the Engineer. As part of the submittal process, the Engineer shall provide a written explanation with justification for design options incorporated which differ from these criteria. Systems used shall fulfill the needs of the building, but the economy of operation shall be a prime consideration.

2. Applicable codes and Design Policy drafting are found in SECTIONS 1 and 2 of this Design Criteria. Should any code and this criteria be in conflict, then the code shall take precedence.

B. BASIS OF DESIGN:

A written mechanical Basis of Design shall be submitted to DFCM with the design development drawings. This written Basis of Design shall be resubmitted with any corrections at the Contract Document phase and again included with the operations and Maintenance Manual. The purpose of the Basis for Design is to document and reference basic criteria, letters, pre-design conference minutes, relocation of utilities, pertinent research field investigations, etc. In addition, the Basis of Design can be employed by the owner during future retrofits to understand the original design intent. The basis of Design format shall include:

1. Table of Design Criteria including but not limited to the following:

   (1) Indoor/outdoor winter design temperatures.
   (2) Indoor/outdoor summer design temperatures.
   (3) Envelope "U" values.
   (4) Ventilation rates.
   (5) Internal heat gains (people, miscellaneous, etc.).
   (6) Number of people in facility.
   (7) Diversity factors.
   (8) Chilled water temperature rise through coils.
   (9) Heating water temperature drop through coils.
   (10) Chilled water temperature drop through chiller.
   (11) Air temperature drop across cooling coils.
   (12) Air temperature rise across heating coils.
   (13) Glass shading coefficient.
   (14) Fire protection criteria (available flow and residual pressure).

(15) Domestic water - Existing Main Line size and pressure.
(16) List the design maximum noise levels by identifying NC or PNC curves for each space.

2. Provide a very brief justification for selection of the following systems. No calculations or economic comparisons are required.

(1) Heat source and heat distribution system.
(2) Air conditioning systems.
(3) Air distribution system.
(4) Plumbing system - At construction drawing stage provide the following information:
  (a) Total fixture units cold water.
  (b) Total fixture units hot water.
  (c) Building water pressure at meter.
  (d) Difference in elevation between supply and most remote outlet.
  (e) Length of piping to most remote outlet.
(5) Automatic temperature control system.
(6) Fire protection systems (i.e. sprinkler, Halon, smoke removal).
(7) Special mechanical systems including but not limited to:
  (a) Compressed air systems.
  (b) Exhaust/makeup air systems.
  (c) Liquid petroleum storage and distribution systems.
  (d) Special piping (i.e., acid waste, lubricants, gasses, etc.).
  (e) Water treatment.

3. Computations:

(1) Provide calculations necessary for major equipment sizing, especially refrigeration and heating equipment that will eventually be replaced or involved in future expansion of the facility. State all assumptions involved with sizing-including load diversities.

(2) Provide an inventory of all heat gains in a typical work station including, personal computers, task lighting, etc. Normalize to square foot basis and compare to internal heat gain used in design.

(3) Computerized Calculations:

Provide a copy of all computer runs for HVAC loads, duct sizing, etc. at the construction document phase submittal only.

4. Design capacities presented in <u>normalized</u> fashion for comparison check. Include the following ratios:

(1) Heating: BTUH/SF.
(2) Sensible Cooling: SF/ton.
(3) Latent Cooling: SF/ton.
(4) Total Cooling: SF/ton.
(5) Cooling: CFM/SF.
(6) Cooling: CFM/ton.
(7) Chilled water: GPM/ton.

5. Energy analysis compliance forms shall be included with Basis of Design at Construction Drawing phase.

C. DRAWINGS AND SPECIFICATIONS

a. Contract drawings shall be drawn to scale not smaller than 1/8" = 1' O" unless use of smaller scale drawings is specifically approved for certain unusual circumstances. Drawings shall show elevation by sections or by denoting approximate heights of all main pipes and ducts.

b. Drawings, for remodel projects shall depict existing mechanical systems in layout (floor plan) detail and equipment schedule. The drawings should be self sufficient for reliance upon by building operations and maintenance for full understanding of building operations in area of remodel.

c.

d. All boiler rooms, fan rooms, machine rooms, toilet rooms, kitchens, laboratories and other congested areas shall be detailed fully on plans and sections showing all equipment that might be involved in interferences and shall be drawn to scales not smaller than 1/4" = 1' 0".

e. Provide a key plan showing fire-rated partitions on mechanical (floor plan) drawings.

f. Show room names and numbers on all mechanical drawings, same as architectural drawings. Also, show north arrow and key plan.

g. Separate plans will be required for plumbing. Do not show plumbing on heating and/or air conditioning drawings.

h. Depict design flow rates (GPM, CFM) for each branch and main on drawings.

i. Provide as-built drawings both as the mylar originals and as a computer disk in DSX Format; preferably Autocad.

D. PIPING AND UTILITIES

1. No utility lines other than electrical power are to run

through or in transformer vaults or rooms set aside for electrical items only.

2. Water relief valve exhaust or discharge shall be run to a floor drain which shall be provided nearby.

3. Sleeves through outside foundation walls shall have means for positively sealing watertight around pipes.

4. Pipe that is exposed shall be as specified in ASTM 53. Underground pipe shall conform to ASTM A106.

5. a. Pipe tunnels shall have a minimum walkway of 31 0 clear of any obstructions. The minimum height of tunnel shall be such that there will be a minimum clearance of 6'5" in walking aisle.

   b. There shall be a sump provided in pipe tunnels at each cleanout. Sump shall be three foot square and four feet deep with grating cover and porous walls. Floor drains may be used in lieu of sump if depth of waste line is such that drains may be tied in.

   c. Tunnel shall be well lighted with switches at every entrance. Power outlets should be provided every 50 ft.

6. Where utility lines enter a building below grade or where earth has been disturbed, provision shall be made to preclude damage due to settling. Steps involving adequate compaction or providing special supports should be specified.

E. HVAC

1. Design Conditions:

   a. Select design temperatures per state statute.

   b. The designer shall be familiar with ASHRAE's Standard 55-1981 "Thermal Environmental Conditions for Human Occupancy". Pay particular attention to the minimum relative humidity (RH) in the space. Section 5.1.2 of ASHRAE's Standard 55-1981 states that the dew point temperature in the space shall not be less than 35 degrees F. which, corresponds to approximately 25% RH when the indoor air temperature is 72 degrees F. Humidification systems will be required for 100% outside air systems employed in laboratories and similar facilities.

2. Ventilation Requirements:

The engineer shall comply with the design criteria in ASHRAE Standard 62-1989, Ventilation for acceptable Indoor Air Quality.

In complying with Standard 62-1989, the fee engineer should pay particular attention to:

a. Section 5.4 of the ventilation standard requires the designer to make provision for maintaining acceptable indoor quality when the supply of circulating air is reduced by variable air volume systems.
b. If the engineer elects to comply with this ventilation standard via the prescriptive method of section 6.1.3, recognition of "ventilation effectiveness" must be made. If Table 3 requires 15CFM/occupant, the designer must recognize that this applies to the occupied space. It may be necessary to introduce more than 15CFM/occupant at the air handler due to the inefficiency of the air distribution system (ventilation effectiveness less than 1.0).
c. If unusual indoor air contaminants or sources are present, compliance with the ventilation standard should be sought through Section 6.2, performance method.

3. Zoning:

Design Engineer shall endeavor to reduce number of zones by zoning similar spaces such as offices with the same exposure on one thermostat; generally 2 to 4 rooms on same zone.

4. Dedicated Copy Areas:

If a space is dedicated for copy machines (xerography, wet-process etc.), then this space shall be exhausted to the outdoors in similar fashion to a restroom or smoking area. The Material Safety Data Sheets (MSDS) for wetprocess copier chemicals recommends use of local ventilation in confined spaces due to the organic compounds volatilized during the copying process.

5. Relief Air Path:

Every HVAC system that introduces outside air into the circulating air system must provide a dedicated path f or relief air. Exfiltration through the building envelope does not qualify as a dedicated relief path.

6. Electric Resistance Heating:

The designer will minimize the use of direct electric resistance heating for space heating.

7. Ventilation Effectiveness:
The location, type, and performance of supply diffusers and return grilles in a space determine the ventilation effectiveness of that space. The goal here is to maximize the air exchange rate at the breathing zone of the occupant. It is not uncommon for ventilation effectiveness to be as low as 0.5 resulting in twice as much ventilation air as necessary to meet ventilation standards. For example, the designer should consider the effects of low f low conditions in a VAV system when selecting and locating diffusers.

8. Water Reservoirs in Airstream:
Stagnant reservoirs of water in the airstream should be avoided whenever possible. Cooling coil condensate drip pans should be sloped and trapped properly to avoid standing water in the pan.

9. The HVAC designer shall include an air or water economizer system for all air conditioned spaces. Economizers may be deleted if life cycle cost analysis is accepted by DFCM.

10. The HVAC design shall provide for the continuous operation of the following components through redundancy and/or modularization. The loss of one half or less of the design cooling or heating system for the entire facility will be tolerated temporarily in the event of equipment failure, namely:
    a. Heating pumps.
    b. Boilers.
    c. Refrigeration machinery (excluding cooling towers).
    d. Condensate pumps.

    For buildings less than 30,000 sq. ft. other than residence buildings, redundant equipment will not be required; space shall be allowed for the addition of future redundant equipment as noted above.

F. EQUIPMENT PADS

1. All pumps, air compressors, boilers, chillers, and other equipment shall be set on a concrete base a minimum of 4 inches above the floor.

G. DESIGN FOR MAINTENANCE:

1. If a building maintenance group is already on line during

design, they should be interviewed regarding their maintenance procedures. This information will be useful to the designer for selecting and sitting equipment.

2. Show by a dashed line on the drawings for areas requiring special maintenance access such as tube pulls. Typically, there shall be a minimum of 3011 clearance around all equipment.

3. Catwalks shall be provided to maintain inaccessible equipment. Vertical access to equipment shall be provided with nothing steeper than a ship's ladder.

4. All valves, piping and equipment shall be installed so as to permit disassembly access.

H. INSPECTION. TESTING, & TURNOVER

1. All systems and equipment shall be inspected and tested. A written record inspections and tests shall be maintained and submitted in the operations and Maintenance Manual. (Sample forms are presented in Appendix).
2. If the Fee Engineer specifies instruction of the maintenance group by the contractor then this instruction session will be video-taped. During taping, the Fee Engineer will be present to impart design intent and answer questions. The tape will be presented to the user as part of the 0. & M. Manual typically provided. (Exemption: facilities less than 30,000 sq. ft.).

3. Balancing of HVAC by competent independent engineering firm should be included as part of the specifications. A report of such balancing should be included as part of the operating manual for the building. Balancing Firm shall have approval of DFCM.

4. The contractor shall mark and indicate on a set of blue line prints, furnished by the Architect and kept on the job at all times, any modifications or changes to the work performed. This set of drawings shall be turned to the Architect and DFCM upon completion of the project.

I. OPERATION AND MAINTENANCE MANUALS

1. Upon completion of work and before final inspection, the Contractor is to compile and deliver to DFCM four (4) sets of installation, operating and maintenance instructions for each item of material, equipment and hardware used in the building. This includes, but is not limited to:

   a. Mechanical Equipment.

b. Automatic temperature controls.

c. Heating and Air Conditioning components including pumps, blowers, filters, valves, strainers, traps, reliefs, etc.

d. Plumbing including pumps, fixtures, water motors, backflow devices, etc.

Also other disciplines will be required to submit sections such as:

e. Hardware, including locks, doors closets, hinges, panic devices, etc.

f. Restroom supplies and equipment, including stall partitions.

g. Electrical equipment, including light fixtures, hand dryers, fans, panels, switches, transformers. etc.

2. Each set of instructions is to be bound in a piano hinge looseleaf type binder with a strong, sturdy cover with title of project stamped on outside front and spine.

3.

a. The first section is to contain the following information:

1) First page shall be a Table of Contents and Name of project, DFCM Project Number, date awarded, date of Substantial Completion.

2) Name, Addresses and Phone Numbers of Architects, Engineers and Associates.

3) Names, Addresses and Phone Numbers of Contractors and Sub-contractors and the work to which each was assigned.

4) An equipment list with the names, addresses and phone numbers of suppliers. Each piece of equipment shall described by name, identification number, location and function.

b. The second section is to be completed by the Engineer and shall include:

1) Mechanical Basis of Design as submitted during design.
2) Operating systems descriptions to describe operating modes with single-line diagrams; all setpoints and normal operating parameters for

all load, pressure temperature and flow checkpoints; all alarms and cautions for operations.

3) Schematic control diagrams (blue line prints) for each separate fan system, chiller, heating system, relief air, air conditioning, pump's etc. Each control diagram shall show a schematic representation of mechanical equipment and locations of start-stop switches, insertion thermostats, thermometers, pressure gauges, automatic valves, valves and gauges. The correct operating reading for each control instrument shall be marked on this diagram.

4) In the third section provide a comprehensive lubrication and maintenance schedule for all the equipment.

d. In the fourth section, provide test run and balancing reports. (See Appendix 1 for sample data forms.) Include the following:

1) Floor plans with all air openings and thermometer locations clearly marked and cross-referenced with data sheets. Format may be 8 1/2 x 11 or 11 x 14 if legible.

2) Data sheets showing amount of air handled at each opening.

e. In following sections, devote each section to an individual equipment and provide the following:

1) Equipment Descriptions.

2) Detailed installation, operating and maintenance instructions (not just a product catalog) written in a step-by-step manner identifying start-up, operating, shutdown and emergency action sequences sufficiently clear so a person unfamiliar with that equipment could perform its operations.

3) Equipment drawings, performance curves, operating characteristics, etc.

4) Name, address and phone number of manufacturer fabricator and local vendor.

5) Complete parts listing which include catalog number, serial number, contract number, or other accurate provision for ordering replacement and spare parts.

5) Certified drawings, where applicable, showing assembly of parts and general dimensions.

7) General product catalog.

3. Drawings and reproducible masters of drawings as required in individual specification sections, are not to be bound in volumes, but delivered separate with the maintenance manuals.

15055 PIPING

A. GENERAL

1. No foreign piping allowed. No ABS plastic pipe and no type M copper pipe is to be used for water piping.

2. Copper piping joints shall be made with lead-free solder only.

3. Provide isolation valves as necessary. Minimum requirements recommended are valves for each building, each floor, and branch lines that are 2" or greater.

4. No-HUB connections will not be allowed underground, including floor drain connections.

5. Domestic water pressure serving fixtures shall be maintained at a reasonable operating pressure (i.e. 35-65 PSIG).

6. All concealed natural gas piping shall be welded.

7. Underground water lines shall be cast iron or "Blue Brute". Only cast iron pipe shall be used under building slab or other inaccessible locations.

8. Anytime lines are broken or disconnected they shall be capped immediately after flushing. If rocks or other foreign materials are found in the system after it has been closed the Contractor shall stand the expense of their removal.

9. Pipe shall not be bent to change direction; fittings must be used.

10. Water and waste lines shall be sized, graded, and suspended in accordance with the Uniform Plumbing Code.

11. Water still drains shall be "Kimax" glass or equivalent to the nearest main drain, or glass pipe shall be run for the first 20 feet horizontally or to the floor below. Install

cleanout at water still and at main drain line before glass is connected with soil pipe.

12. Pipes shall be kept out of concrete slab floors and shall be run overhead wherever possible. Pipes on top floors must be below building insulation.

13. The mechanical contractor shall be responsible for all utility lines inside contract lines and outside where changes are necessary for construction, and shall repair lawn sprinkling systems, existing laws, sidewalks, roads, and utility lines broken by contractor or sub contractor during course of construction.

14. Depth of bury of outside services shall be:

	Greater than 6000 HDD		Less than 6000 HDD	
	Minimum	Preferred	Minimum	Preferred
Water	48"	60"	36"	48"
Gas	24"	36"	24"	36"

15. Water and drain lines shall be installed in food vending machine areas for coffee and soft drink machines.

16. Provide faucet with hose attachment and vacuum breaker in each restroom so floor can be washed with clean water.

17. Provide hose bib with vacuum breaker in mechanical rooms and chiller rooms. Provide non-freeze hose bib with vacuum breaker near Cooling Tower.

18. All pipes and conduits or any lines passing through floor shall have a water-tight sleeve and water-tight caulking around pipe.

19. No plastic piping allowed, except for special uses such as acid drains, deionized water, snow melt systems.

B. P-TRAPS

1. Cleanouts and plugs are not to be provided on P-traps. This applies to both brass and cast iron P-traps.

2. Use deep seal P-traps on all floor drains.

C. HOSE BIBS

1. Hose bibs shall be installed outside building to provide water for window washing, walk and areaway washdown, generally not less than 150 feet apart.

2. Hose bibs to be non-freeze type.

3. Hose bib lines shall be valved separately with shut-off valve located inside building.

4. All hose bibs are to be installed with atmospheric, vacuum breakers.

D. CLEANOUTS

1. Provide cleanouts on rainwater lines in accordance with code provisions for sewage line.

2. Provide cleanouts at base of each vertical rise, each turn in excess of 45 inches and on straight runs every 50 feet.

3. If piping is not accessible or is run below slab, extend up to finished floor and provide acceptable cleanout cover.

4. Cleanouts in piping outside building shall be extended to grade with adequate covers for planted, concrete, or driveway areas.

E. FLOOR DRAINS

1. Floors shall slope to drains. Restroom floors and other floors where there will be water or where water may get on floor shall be tested with water to make sure floors are water tight and there are not places where water stands. Include water test with other plumbing tests specified.

2. Membrane or lead waterproofing pans for shower stalls and custodial floor sinks shall be installed by plumbers so they are 100% water tight. Drains shall have clamping device which clamps drain to pans. There shall be a mastic seal between floor drain bottom and lead or membrane so when clamping device is tightened there is a complete seal so no water can get through. Care should be taken not to clog weep holes. All pans will be tested by placing test plug in drain and filling with water overnight. The DFCM Inspector will inspect pans before tile is laid. Refer to Uniform Plumbing Code.

F. ROOF DRAINS

1. Roof drains to be not less than 3 inches.

2. Walk-in refrigerators and other places where food is stored shall have drains indirectly connected to building drainage system.

4. Trenches with grating covers with bottoms sloped to drain are preferred over multi-floor drains in mechanical equipment rooms, some types of laboratories, and especially boiler rooms.

G. SPRINKLER SYSTEMS (IRRIGATION)

1. All exposed electrical control wiring used for automatic sprinkler systems shall be installed in approved electrical conduit with approved electrical fittings and comply with the requirements of Division 16.

2. Primary PVC sprinkler systems shall be schedule 40 with fittings rated at 200 PSI.

3. Large sprinkler piping (3" and greater) should be designed as water mains for pressure, materials, thrust blocks, etc.

15100 VALVES

A. GENERAL

1. All branch lines of water and steam which supply more than one outlet or unit shall be valved near the main with a union, so areas of the building may be shut down for repair without having to shut down large areas.

2. Valves 2" and larger shall be flanged on systems greater than 200°F.

3. Valves should be installed, with bonnets at least 45 degrees above the horizontal to ensure debris does not collect in bonnet.

B. STEAM

1. Low pressure steam valves shall have a 200 psi rating and allow renewable seats and discs.

2. For 100 psi steam line use 250 psi flanges and 300 psi screwed valves.

C. WATER

1. Provide valves on hot and cold water lines to each restroom so that water may be shut-off before entering restroom. Valves shall be located where they are accessible from floor (in pipe chase, walls, etc.). Access doors shall be provided for each valve and adequate room left to work on valve.

2. All sinks, lavatories and wash basins shall have a shutoff valve on all water supply lines on the room side of the fixture. All valves must have a gasket seat, not a ground joint. Supply lines from the valve shall be 3/8" brass, chrome plated.

3. Water closets and urinals shall have screwdriver stop valves on flush valves. Flush valves shall be of the exposed typed.

4. All valves on water line three inches and smaller shall be globe valves with a soft disc (Crane #7 or equal) . To accommodate for loss due to restriction use one size larger valve than pipe. Gate valves are not acceptable. Ball valves with full opening ports and adequate pressure and temperature rating may be used in lieu of globe valve up to two inch size; over two inch size butterfly valves with wheel and gear operator may be used.

15135 METER AND GAGES

A. WATER METER

1. Each building shall have a compound water meter installed in the water line serving the building in accordance with the local water authority.

2. For campus buildings the meter shall be installed in the main mechanical room or within easy access mechanical spaces. If conditions do not permit inside installation, a meter box may be installed outside. Where fire sprinklers are installed, the fire main shall be connected ahead of the meter. This may be done inside the facility provided all codes are met. Typically, installation shall be completed before any water is used for construction purposes. The Contractor's water for construction shall come from the metered line.

3. Where outside meters are used, the meter box or vault shall be 51 x 81 x 71 high with a concrete base under the meter, but the rest of the floor shall be gravel. Top shall have recessed eyes. Top to be poured separate so it can be moved off with a crane and the eyes shall be left large enough to insert a chain by which it can be lifted. Cover to have a 24 inch locking meter lid in center. Position of meter shall be such that it can be read without personnel entering the vault.

4. Water meter indicator shall be of the totalizer type reading directly in gallons of water. Water meter shall be installed with valves on both sides so meter can be removed and a by-pass line installed. Sleeve around pipes passing through walls of meter box.

15170 MOTORS

All motors one HP and above shall be high efficiency with efficiency ratings consistent with NEMA Standard MG 1-12, 55A, Efficiency Levels of Energy Efficient Polyphase Squirrel - Cage Induction Motors. Values are found in Table 12-6C of the NEMA Standard. Motors used for VAV applications shall be compatible and designed for use with Variable Frequency Drives if this method of volume control is used in the project.

15190 MECHANICAL IDENTIFICATION

A. VALVE TAGGING

1. All valves shall be designated by distinguishing numbers and letters on required charts and diagrams. The Contractor shall furnish and install approved brass tags for all designated items, with numbers and letters on the tags corresponding to those on the charts and diagrams.

2. Brass tags shall not be less than 1 1/2" diameter with depressed black-filled numbers not less than 1/2" high and black-filled letters not less than 1/4" high. Tags shall be securely fastened to valves with approved brass "S" hooks, or brass jack chain, in a manner to permit easy reading. Do not attach to valve wheel or the valve handle. Brass tags shall be as manufactured by Seton Name Plate Company, New Haven, Connecticut or approved equal.

3. Each valve shall have an identifying number identifying the unit. Standard identifications may be used for identifying type of service or fluid in pipe. The Engineer shall submit his system of identification to the DFCM for approval.

4. A chart of all valves shall be furnished as part of O & M Manual by the Contractor. Charts shall indicate the following items:

a. Valve identification number
Location
Service or purpose
Normal position

b. One chart to be mounted in a frame with clear lexan front, and secured on a wall in the equipment room(s), or in a location as otherwise directed by the Architect.

c. Another chart shall be prepared for use outside of the equipment room, and to be provided with an approved heavy transparent plastic closure for permanent protection. Two (2) holes to be punched at top of plastic closure to allow for affixing approximately an 811 length of nickel plated bead chain. Each hole to be reinforced by means of a small brass or nickel grommet. Plastic closure shall be as manufactured by Seton Name Plant Company, New Haven, Connecticut or equal.

5. Sample Identification Chart is as follows:

VALVE IDENTIFICATION CHART

NUMBER	DESCRIPTION	LOCATION*	NORMAL POSITION
1.	Cold Water Supply to Water Heater	Mech. Rm. #121	Open
2.	Cold Water Supply to Hose Bib	Room #13	Open
3.	Cold Water Supply to Equipment	Room #18	Open
4.	Sprinkling System Drain Valve	Tunnel Below Room #115	Closed
5.	Hot Water Supply to Toilet Room #212	Chase #210	Open
7.	Heating Hot Water Balancing Above Ceiling Marked Valve (Southwest Zone)	Room #412	On Valve

* The above room numbers shall be the room numbers actually used. DO NOT USE ARCHITECTURAL ROOM NUMBERS ON PLANS. Use institution actual assigned room numbers.

B. EQUIPMENT IDENTIFICATION

1. Equipment including gauges, meters, mechanical equipment, electrical panel boards, switch boards, motor control centers, motor starters, fire alarm junction boxes, safety switches, transformers (outside of main vault), high voltage feeders, etc. and all other devices shall be identified with signs made of laminated plastic with 1/8" or larger engraved letters.
2. Each equipment shall have its own unique equipment number.
3. Information on sign shall include name of equipment, identification on plans and schedules, rating, maintenance instructions and any other important data not included on factory attached name plate.
4. Signs shall be attached to equipment so they can be easily read. Attachment shall be by rust proof screws or rivets. Glue shall not be used.
5. Sample identification signs for equipment shall be as follows:

   a. "Supply Fan Auditorium F-2
   Rating: 49,850 cfm @ 3.511 s.p. (at 4775 ft. elev.)

   Maintenance: Check bearings for lubrication every 30 days and lubricate as required with S.A.E. 30 oil"

   b. "Heating Hot Water Pump Classroom Area
   156 gpm @ 57 ft. head"

   c. "Motor Control Center MCC 211

   d. "Lighting Panel LZIA"

   e. "Safety Switch Fan FZII

   (NOTE: Avoid using only the engineer's designations as used on plans; identify equipment as to area or zone served.)

C. REMOVABLE AND NON-REMOVABLE CEILING TILE

1. Where valves, mixing boxes, fire dampers, adjustment controls, etc. Are located above ceiling tile, an identification on the lay-in tile tee bar shall be provided to indicate the tile to be removed for access to a particular item. In general 1/2 inch high black stickon or stencil letters are to be used indicating the device such as MB for

mixing box, CWV for cold water valve, SV for steam valve, FD for fire damper, FAJ for fire alarm junction box, E for other electrical devices, etc. The code used shall be provided in the operations and maintenance manual.

D. DUCT IDENTIFICATION

1. Ductwork shall be identified at or near the fan, with stenciled signs or by engraved laminated plastic signs secured with rust proof screws. Sign shall indicate area served.

2. Identify all ducts exposed in mechanical equipment room. A sample duct identification shall be as follows: "Supply Hot Duct-Heating Auditorium Wing."

E. PIPE IDENTIFICATION

1. All pipes are to be labeled and color coded with contents clearly identified and arrows indicating direction of flow. This applies to piping run above the ceilings and in pipe tunnels as well as pipe exposed in equipment rooms and finished areas. Pipes shall be identified at the following locations:
   (a) Adjacent to each valve.
   (b) At every point of entry and exit where piping passes through a wall or floor.
   (c) On each riser and junction.
   (d) A maximum of every 50 feet on long continuous lines fully exposed to view. Less spacing if one cannot see one code from the adjacent.
   (e) Adjacent to all special fittings or devices (regulating valves, etc.).
   (f) Connection to equipment.

2. Apply markers so they can be read from floor. Labels and markers shall be of the self-sticking, all temperature, permanent type as manufactured by W.H. Brady Co., 727 West Glendale Avenue., Milwaukee, Wisconsin; or Seton name Plate Corp., 592 Boulevard, New Haven, Connecticut.

3. Pipe color coding shall be uniform throughout the campus and new systems shall match existing systems. Background colors shall be as follows:

   Yellow: Dangerous Materials (high pressure steam, natural gas, condensate, high pressure refrigerant, high voltage, etc.)

   Red: Fire Protection Equipment (Fire Sprinkler Water, Fire Protection Water).

Bright Blue: Protective Materials (Filtered Water)

Green: Safe Materials (Chilled Water, cold Water, Instrument Air, Sanitary Sewer, etc.

4. Letters of identification legend shall be 2" high for pipes 3" and larger, and 1" high for pipes 2 1/2" and under.

5. Markers shall be installed in strict accordance with manufacturer's instructions.

   On chalky and loose insulation, soft, porous, fiberfilled or fiberglass coverings, a spiral wrap of pipe banding tape shall be made around the circumference of the pipe. Sufficient spiral wraps shall be made to accommodate the horizontal dimension of the pipe marker.

   On bare pipes, painted pipes, and pipes insulated with a firm covering pipe banding tape matching the background color of the marker shall be used for 360 color coding. After applying pipe markers, wrap pipe banding tape around pipe at each end of marker. Tape should cover 1/4" TO 1/2" TO 1" on itself. Be sure pipe surface is dry and free of dirt or grease before applying markers or banding tape.

6. Stenciling may be used in lieu of the above labels and markers if finished application gives the same overall appearance. If stenciling is used, letter heights, background colors, banding and arrows shall be as specified above. Submit samples before proceeding with work.

15250 MECHANICAL INSULATION

A. SCOPE

1. Completely insulate the following systems:
   (a) All refrigerant suction piping.

   (b) All supply and return heating piping.

   (c) All supply and return chilled water piping.

   (d) All domestic cold water piping above ceilings.

   (e) All domestic hot water piping and recirculation lines.

   (f) Roof drain and overflow piping as follows:

      (1) Horizontal piping above ceilings.

      (2) Vertical piping below roof drain bowl.

      (3) Roof drain bowls.

2. Insulate pipes in thicknesses dictated by economics and energy statutes.

3. Exposed insulation in areas subjected to damage shall have protective covering.

B. Exterior Piping Insulation:

1. Cover all insulation with aluminum jackets secured with aluminum bands 12 inches o.c.

2. Seal Joints watertight.

3. Use of PVC jackets may be used if properly protected from UV damaged and all joints are chemically welded.

15300 FIRE PROTECTION

A. FIRE HYDRANTS

1. Fire hydrants are to have a 4 1/2 inch N.S.T. pumper connection and two 2-1/2 inch N.S.T. hose connections, 1 1/2" pentagon operations nut-open left, sidewalk flange with break bolts, mechanical joint auxiliary gate valve and valve box.

2. All hydrants to have "National Standard" thread (N.S.T.) or as required by local Fire authority.

3. Placement of hydrants shall be in locations which are accessible to service walks and drives while still being able to reach all major portions of the building.

B. Fire Rated Assemblies shall be specified and details shown in the drawings.

15440 PLUMBING FIXTURES

A. TOILET ROOM FIXTURES

1. Toilet room fixtures shall be wall hung for two or more within one restroom.

2. Flush valves shall be exposed type with lever operator (no push buttons), diaphragm type only. No tanks allowed.

3. Toilet rooms and utility rooms are to have floor drains.

4. Fixtures to be all of one type in any one building.

5. If space and budget allows, flush valves may be concealed.

Provide chases to access valves. Handles or push buttons to actuate concealed valves shall be mounted high enough to require hand, rather than foot operation. Don't mount too high on sidewall to present barriers for the physically handicapped. In restrooms subject to vandalism, concealed flush valves will be employed.

6. "Hand free" sensor actuated valves are acceptable.

B. SHOWERS

1. Shower valve shall be non-scald type with integral stops.

2. Shower heads shall be institutional type with flow adjustment and adjustable head and spray. Head must extend out from wall so water does not run down wall when valve is turned off. Heads should be vandal proof.

3. Shower escutcheon shall be water tight with weep hole in bottom.

C. DRINKING FOUNTAINS:

1. All drinking fountains shall be of the refrigerated type, wall hung with all stainless steel cabinet (Halsey Taylor SM-16A or equal).

2. Where more than eight (8) units are provided, check feasibility of using central water chiller for cooling water.

3. Drinking fountains should have a removable grid strainer to enable cable-style cleaning without having to dismantle the fountain.

D. WATER HEATERS

1. Piping wiring and equipment shall be installed so that it will not interfere with the removal of heating coils for periodic cleaning.

2. Unions shall be installed in all connecting piping to facilitate the removal of piping.

3. Consideration should be given for expansion in the hot water system.

4. Include combination temperature and pressure relief valve sized to ASME requirements and piped to adequate drain.

E. KITCHEN EQUIPMENT

1. Use indirect connection for waste on automatic dishwashing machines. Discharge into J.R. Smith Fig. 2435 or equal heavy duty drain with internal trap and large sediment bucket. Drain to be installed accessible under conveyor table and shall be three inch minimum.
2. Waste discharge from garbage disposal units shall connect directly to horizontal waste line without sinks or other equipment connected to the same line. Horizontal waste lines serving garbage disposal units shall be three inch minimum and shall have adequate cleanouts.

15488 NATURAL GAS SYSTEMS

A. A Seismic Gas Shut Off Valve shall be installed per manufacturer's instructions for each natural gas system in Seismic Zone III.

15510 HOT WATER HEATING SYSTEMS

A. General
1. Hot water heating systems are preferred.

2. Design for reversed return. Departures from the standard two-pipe reversed return system must be indicated at the time of submittal of Preliminary Drawings for review, together with a system analysis to indicate reasons for departure.

3. Air separators and expansion tanks shall be provided for all hot water heating systems regardless of piping arrangement. Tie air separator into piping system on suction side of circulating pump.

4. Piping system shall be provided with manual air vent valves at system high points and drain valves at system low points. Suitable provisions, such as access panels, shall be furnished in building construction to permit full access to these valves. Manual air vents shall be 3/8" globe valves with 1/4" copper tubing to near floor or to location where water may be caught in bucket. Drain valves shall be threaded for 3/4" hose connection.

5. Hot water preheat coils shall not exceed 6 fps water velocity and coils shall be provided with circulating pumps to provide constant circulation through the coil tubes.

6. Install flow metering devices, such as "Rincoll venturi meter.

7. All heating producing equipment (convertors, unit heaters, coils, etc.) should be provided with suitable air vents. No

soldered joints will be allowed.

8. Maximum friction loss shall be 4 ft. per 100 ft. of pipe.

9. Where applicable, the engineer shall provide perimeter hydronic piping subcircuits to match the perimeter air distribution zones. For example, if a building is heated with a perimeter radiant system, then the designer shall provide the necessary piping subcircuitry and controls so that heating and cooling zones are nearly matched.

B. PUMPS

1. Install pressure gauge with gauge cocks as close to pump suction and discharge as possible. It is not desirable to have to calculate drops across valves, strainers, flexible connectors, etc., to determine pump performance.
2. Provide suitable throttling valve on discharge side of all pumps, such as globe valve, butterfly valve or balancing cock. Throttling valve shall have set point position indicator and shall not be used for shut-off valve.

15520 STEAM AND CONDENSATE

A. PIPING

1. All steam pipe 211 and smaller shall be Schedule 80 black steel; sizes 2 1/2" and larger shall be Scheduled 40 black steel for low pressure steam (15 PSIG or less) and Schedule 80 black steel for high pressure steam (higher than 15 PSIG).

2. All condensate return lines shall be Schedule 80 or Schedule 80 Yoloy pipe, including underground return lines.

3. Z-crete, Ric-wil, Portage and Durrant insulated underground pipe are approved for underground steam line extension. Ric-wil insulated piping will be approved only if steam and condensate return piping are run in separate insulated conduits. Backfill piping with sand to 12" below finished grade.

4. Ample provision must be made for expansion of piping., using expansion loops, swing joints, offsets, etc., as may be required. Expansion joints shall be used only when expansion loops, offsets, swing joints, etc., are not practicable. When expansion joints shall have adequate internal or external guides, and shall be properly supported and anchored. Swing joints shall not be used on main runs, but only on risers off the main.

5. All steam mains must be properly dripped. Provide drip legs ahead of all steam pressure reducing valves and steam coils to insure clean, dry steam at the valve.

6. Piping shall be run in tunnels or in crawl space large enough for workmen to make necessary repairs. No pipe shall be buried under floors or run in split tile, and access door shall be provided where pipes are run between floors.

7. Provide eccentric reducers when changing pipe sizes.

B. PRESSURE REDUCING STATIONS

1. Where pressure reducing stations are used, use pilotoperated valve. A "three-valve" by-pass shall be installed at all reducing stations with ample clearance to permit normal maintenance and inspection. Recommend parallel pressure reducing stations when low demand is expected.

2. Safety relief valves shall be installed on the low pressure side of regulator stations. Discharge pipe shall be run to outside the building. Pipes discharging near grade shall be run into eight inches concrete tie set upright in the ground (buried) over a gravel base twelve inches deep.

3. Pressure gauges shall be installed on both the high pressure and low pressure sides of all regulator stations. Locate gauges so they will function when bypass is used.

C. MAIN BUILDING STEAM VALVE

1. For campus distribution systems, each new building shall have a motor operated steam valve. Location of steam valve to be coordinated with institution.

2. Since this valve may be closed during the summer months, any steam lines serving equipment which must operate during summer (such as hot water generator, auto claves, sterilizers, etc.) shall be connected ahead of this valve.

D. STEAM METER

1. Steam meters shall be installed in each building to record steam consumption for the entire building. The steam meter shall be installed and operable before steam is turned into building. Meter shall be of the totalizing type. Meter shall read directly in pounds of steam.

E. CONDENSATE PUMP

1. Condensate pumps are required to return condensate from building to main underground lines. Installation of the condensate return pumps in a pit or looping of return lines around doors and other obstructions to permit gravity flow of condensate is preferred to the use of vacuum pumps.

F. CONVERTERS

1. Side inlets and side outlets to be used on all converters. Converters shall be so installed that coils or tube bundles may be removed without interference with piping or other equipment.

2. Install pressure gauges with snubbers on the primary and secondary side of each converter.

3. Install thermometers on the inlet and outlet of the secondary side of each converter.

15548 WATER TREATMENT

A. DESIGN CRITERIA

1. Provide water treatment for:

   a. Heating water systems.

   b. Chilled water systems.

   c. Condenser water systems.

   d. Steam systems.

2. For one year, supply chemicals and appropriate on site service by water treatment company.

3. Mechanical Contractor shall maintain adequate treated water in Heating System until building is accepted by Owner.

15555 BOILERS

A. DESIGN CRITERIA

1. Provide boiler backup by redundancy or modularization techniques. (See 15010 HVAC).

2. All boilers should be sized amply to provide capacity for:

   a. Altitude derating, piping losses, pickup, fouling, cold combustion air and future loads if identified in programming.

3. Controls shall meet ASME CSD-L.

4. Instruct contractor to notify the Industrial Commission of Utah for a boiler inspection prior to occupancy of building.

5. The fee engineer will be responsible for securing necessary construction permits from the Utah Department of Health, Bureau of Air Quality when required.

6. If a power burner is employed, the fee engineer will contact the manufacturer of the boiler to determine the recommended maximum allowable length of positive pressure flue.

15610 FURNACES

A. DESIGN CRITERIA

1. Multiple furnaces, one for each environmental zone, may not be employed in lieu of centrally fed zoning systems (i.e. VAV, MZ, etc.) The rationale for this exclusion includes:

   a. Multiple points of combustion scattered throughout a facility is obviously less safe than containing this combustion and gas piping to a single firerated mechanical room, penthouse or roof-top unit.
   b. The small CFM (less than 2,000) capacities of the furnace typically falls within the UMC exception for automatic shut down on smoke detection.
   c. Multiple penetrations of a roof assembly for flues, combustion air and ventilation air is less desirable than a single location.
   d. DFCM Criteria requires economizer cycle on all fan systems. To provide economizer controls for each furnace unit is costly and unreliable.
   e. Most occupants expect a furnace fan to run intermittently as does their home furnace. Many times,

this results in defeat of controls provided to run the fan continuously during occupied hours to bring in adequate ventilation air.

f. Heat exchanger failures can result in carbon monoxide poisoning of the zone occupants. These failures typically go unnoticed as carbon monoxide is odorless.

15620 UNIT HEATERS

A. DESIGN CRITERIA

1. Fans:

a. If a unit heater is higher than 10' A.F.F., a centrifugal blower shall be utilized rather than a propeller fan.

2. Controls:

a. Provide all gas or oil unit heaters with 2-stage thermostats. on call for heat the first stage cycles the fan. The second stage fires the burner.

3. In shop applications with dusty or corrosive atmospheres, use sealed combustion units that bring combustion air from outside space.

15650 REFRIGERATION

A. DESIGN CRITERIA

1. Water Chiller Efficiencies:

a. Specify performance criteria for the manufacturer to meet. Employ appropriate ARI Standards to standardize your expectations. For example: If a centrifugal chiller is employed, the fee engineer should specify a minimum Application Part Load Valve (APLV) as determined by ARI Standard 550-latest edition. ARI certification or witness testing of all machines should be provided by the manufacturer.

2. Continuous operation should be provided through redundancy or modularization. (See 15010 HVAC).

15710 COOLING TOWERS:

A. Cooling towers shall be tested for operating efficiency at installation. This establishes a performance level that can be used in future testing. Comply with ASME PTC -23-58 or the Cooling Tower Institute Acceptance Test Code (ATC)-105 test procedures.

B. Cooling towers in excess of 200 tons shall have ceramic fill material.

15851 ROOFTOP AIR HANDLING UNITS

A. DESIGN CRITERIA

1. Rooftop air handling units are generally not a preferred system for use on state buildings. If rooftop air handling units are accepted for a project, they must incorporate all items in this section and requirements from Division 15 which apply to the air distribution system. All units to be equipped with economizer cycle with separate, motorized fresh, return and relief dampers automatically controlled and prewired at the factory. Economizer control and damper configuration shall be capable to introducing up to 100% OSA. The control changeover from mechanical cooling to economizer operation shall be fully automatic through an adjustable outdoor air changeover thermostat.

2. Economizer shall have a fixed minimum control to admit OSA for continuous ventilation during occupied periods.
3. Unit shall be located so that the FA intake does not ingest products of combustion from flues, sewer gas from sanitary sewer vents or powdered snow from the roof. In addition, the rooftop unit should be located so as to avoid the effects of low atmospheric pressure areas caused by the wind accelerating over parapets, screen walls, penthouses, etc. DO NOT PUT THESE UNITS DOWN IN ROOF WELLS.
4. Easy roof access must be provided from inside the buildings.
5. Provide walk-pads around and to units to protect roof.
6. All gas piping on roof shall have a union every 20 feet to allow removal during reroofing.
7. All condenser sections shall be covered by louvered sheet metal casing. No exposed fins allowed.

15880 AIR DISTRIBUTION

A. FILTRATION:

1. As a minimum, all air handling equipment shall be fitted with filters in the medium efficiency category having an average efficiency of 25 to 35% as per ASHRAE Test Standard 52-76. Engineers employing equipment like residential furnaces, small rooftop equipment and fan coil units should insure that their equipment choice can be fitted and operate properly with these medium efficiency filters.

2. In your specification, instruct the contractor to replace all filters prior to building occupancy and have the contractor provide one replacement set of filters for the entire facility.
3. For large air handling stations exceeding 10,000 CFM, provide pressure differential instrumentation across the filter bank to be used by the maintenance staff as a filter replacement indicator.

B. DUCT LINING:

1. The proliferation of duct lining throughout HVAC air distribution systems is significant. Duct lining has been implicated as the source of contaminants in "Sick Building" studies. It serves as a trap and reservoir for fungal spores. The adhesives used to manufacture the liner and attach it to the ductwork in many cases contain formaldehyde. In addition, long term epidemiological studies have not conclusively confirmed that there are no health risks associated with fiberglass fibers. Consequently:

   a. Avoid lining outside air ducts. This will trap spores found naturally in the outside airstream. Any rain or snow ingested will provide an excellent growth medium for spores. Sound attenuation between the outside and the air handler is typically not required.

   b. Avoid where possible lining ductwork immediately downstream (approximately 10 feet) of any device that adds moisture to the airstream. This includes equipment such as direct evaporative units and humidifiers.
   c. Avoid lining ductwork exposed to humid airstream above 70% RH such as swimming pool applications. Microbiologically, fiberglass exposed to humid air in the supply airstream is not a good idea.

   d. The practice of lining ductwork for acoustic treatment and insulation should be minimized. If sound attenuation is required, then appropriate sound traps should be employed. If insulation is required, wrapping of duct exterior is entirely acceptable.

   Duct lining is porous and acts like a filter trapping dirt in areas where cleaning is impossible. This dirt provides nutrients for micro-organisms which become active in episodes like building flooding or carpet cleaning without adequate moisture removal. In addition, less fan HP is required due to lower friction loss of smooth ductwork.

C. MATERIALS:

1. Fabricate rectangular and round ductwork from galvanized steel, stainless steel or aluminum.

2. No fiberglass ductwork formed from resin bonded fibrous glass rigid boards is allowed.

3. All volume adjusting devices should be of a type that can be securely locked in place and accessible for adjustment after construction is complete.

D. DUCTWORK:

1. Ductwork shall be classified and tested according to the latest editions of SMACNA'S, Duct Construction Standards.

15950 AUTOMATIC TEMPERATURE CONTROLS

A. GENERAL

1. Use of direct digital control in all new facilities shall be required. (Exception, in campus applications where operations personnel specify pneumatic control to match existing peumatic systems.)

2. The direct digital systems shall be programmable through a menu driven type software. Modifications to the program shall not require a knowledge of the computer program language. The direct digital control shall be of the distributed intelligence type, not relying on a personal or minicomputer head end for operation.

3. The direct digital control system shall include but not be limited to: Automatic time scheduling for,start/stop scheduling of building loads (occupied, holiday/weekend and temporary day schedules, economizer control, optimized start/stop, demand monitoring/load shedding, DDC (logic functions), zone temperature control, night setback/setup, morning warmup, proportional-integralderivative control, floating and two position control, alarm capabilities, manual override capabilities, equipment trending, historical archiving of trended information, self testing of operating system and communications integrity.

4. Where pneumatically driven devices are desired E/P transducers or equivalent, controlled from the direct digital control system shall be used.

5. Where new systems tie into or affect existing systems, both systems must be completely operable after the new installation is complete.

6. Do not mount any control equipment on vibrating surfaces.

B. DRAWINGS

1. Include complete temperature control diagrams on building working drawings, including proper coordination of campus automation tie-in.

2. Schematic equipment and wiring diagrams showing all controls equipment installed in the building shall be furnished upon completion of the project. Diagrams shall be framed and mounted under glass of Plexiglass and mounted in Equipment Room(s) adjacent to panels.

3. A mylar reproducible shall be provided of the as-built system schematic.

4. Thermostats shall be solid state when existing systems support DDC monitoring.

5. For several rooms on one zone, recommend the thermostat have an adjustable band limited to +/- 2 degrees about the set point.

C. THERMOSTATS

1. Thermostats in laboratories, classrooms, auditoriums, similar spaces shall have locking metal covers, concealed adjustment, thermometer and with low differential. Thermostats in offices to be the same as above except with exposed adjustments.

2. Thermostats in corridors, halls, restrooms and other similar unsupervised areas shall be of the flush mounted, aspirating type with stainless steel cover.

3. Room thermostats should be mounted 48" above the floor. No thermostat shall be located on outside walls or on partitions between offices if other locations are possible.

D. CONTROL AIR PIPING

1. The contractor shall furnish and install a complete piping system including underground control lines for the pneumatic control equipment. Piping, in general, shall be virgin high density polyethylene plastic or type "L" hard drawn copper tubing with sweat fittings. Piping in equipment rooms shall be installed exposed, securely attached to the structure or to the equipment and run parallel or at right angles to the structure. Piping installed outside the Equipment Rooms shall be concealed in walls or above the ceiling. This piping shall be placed in these locations as required by the progress of the structure.

2. Piping in concrete or masonry walls or floors shall be run in metal conduit to a point accessible in the ceiling or below the floor.

3. Where piping is installed in furred ceilings, it shall be attached to the ceiling construction members in an approved manner.

4. Provide sleeves for piping passing through concrete or masonry walls and floors to protect the piping.

5. Piping shall not be run concealed under duct insulation, inside of ducts, or in direct contact with surfaces colder than normal room temperature, such as outside air ducts, conditioned air supply ducts, etc.

6. All piping shall be supported using hangers of the clamp type with these being securely attached to the structure or equipment.

7. The use of plastic tubing (high density black polyethylene tubing -60 to 220) may be used for general piping and for final hook-up inside control panels and adjacent to high velocity mixing boxes. Tubing shall be protected from hot surfaces. All connectors between plastic and copper tubing shall be of the compression or barbed type. Connectors shall be suitable and manufactured specifically for this application.

8. The entire air piping system shall be tested by placing it under 30 psi air pressure for 24 hours. During this period, the pressure drop shall not exceed 1 psi.

E. AIR COMPRESSOR

1. Compressors shall be of the belt driven type and shall be furnished with belt guard, outside air source with intake muffler, refrigerated after-cooler, stop valve, strainer, pressure reducing valve, pressure relief valve, tank drain, and two (2) pressure gauges.

2. Air compressor shall not operate more than 1/3 of the time.

3. Air compressor and tank shall be installed on 4" high concrete bases.

4. Isolation and sound dampening is required.

5. Compressors above 5HP shall have offloading.

F. CONTROL VALVES

1. All control valves shall have visual position indicators.

2. Install control valves with stem in the vertical position.

3. Packless type valves are preferred.

4. "Self-contained" automatic valves are not satisfactory.

G. DAMPERS

1. Fresh air and exhaust air dampers shall be of the low leakage design and shall have felt or neoprene edges.

2. All modulating dampers to be of the opposed blade type. Maximum blade width shall not exceed eight inches.

3. Fresh air dampers shall close in fan shutdown or power failure.

4. Damper blades shall have steel trunnions mounted in bronze sleeve bearings or ball bearings. Dampers shall be not more than 48 inches in length between bearings.

5. Dampers shall be guaranteed to close substantially tight, and shall provide substantially the full area of the opening when open. Dampers shall have substantial bar or channel frames, and rectangular dampers larger than four square feet in area shall have additional corner bracing.

H. PANELS

1. Equipment room panels to be made of steel not lighter than No. 14 gauge or of aluminum not lighter than No 12 gauge. Doors to be equipped with hinges, latches, and locks. Panels shall be secured to walls, columns, or floors with ample clearance for access to piping and wiring. Steel panels to have backed enamel finish. Provide two (2) keys for each panel.

2. Control devices, relays, piping, wiring and terminals shall be within the cabinets, except that switches, pilot lights and push buttons shall be mounted on the cabinet door.

3. Each piece of equipment on the panel or in the cabinet shall be identified by a name plate. Name plates shall be engraved plastic or metal. Painting or lettering directly on the surface of the panel will not be permitted.

I. CONTROL WIRING

1. All H.V.A.C. control wiring shall be installed in metal conduit and comply with all applicable requirements of Division 16.

2. Control wiring less than 50 volts may be installed in 1/2" conduit and complies with the conduit fill requirements of NEC Table 3, Chapter 9. This requirement supersedes all others.

3. All control wiring shall be routed to a central location required for DDC control.

MECH - APPENDIX 1

INSPECTION, TESTING AND TURNOVER

FORMS

TABLE OF CONTENTS:

DESIGN CRITERIA – March 10, 1995

State of Utah – DAS – Division of Facilities Construction and Management

EQUIPMENT TEST RECORD

PROJECT _____ DFCM PROJECT #_____

EQUIPMENT DESCRIPTION _____ EQUIPMENT NAME_____

EQUIPMENT SERVICE _____

MECHANICAL NAMEPLATE DATA (motor nameplate data supplied on other sheet)

MANUFACTURE R _____ SERIAL NO. _____

MODEL NO: _____ TYPE: _____

_____ RPM: _____

COUPLING TYPE: _____

EQUIPMENT CHECK DATA:

COUPLING ALIGNMENT SHEETS SUBMITTED: _____

LUBRICATION TAGS ATTACHED: _____

NOISE LEVEL ACCEPTABLE: _____

VIBRATION ACCEPTABLE _____

BEARING TEMPERATURES ACCEPTABLE (TOP CONTACT TEMP UNLESS OTHERWISE INDICATED

LOCATION _____ TEMP. (STABILIZED) _____

_____ _____

_____ _____

ALL SPECIAL SETTINGS COMPLETED (WHERE REQUIRED): _____

ALL ASSOCIATED INSTRUMENTATION COMPLETE AND CALIBRATED: _____

MOTOR AND CONTROL TEST RECORD ATTACHED: _____

COMMENTS:_____

_____

_____

_____

CONTRACTOR:_____

REPRESENTATIVE'S SIGNATURE: _____ DATE: _____

_____

DESIGN CRITERIA – March 10, 1995
State of Utah – DAS – Division of Facilities Construction and Management

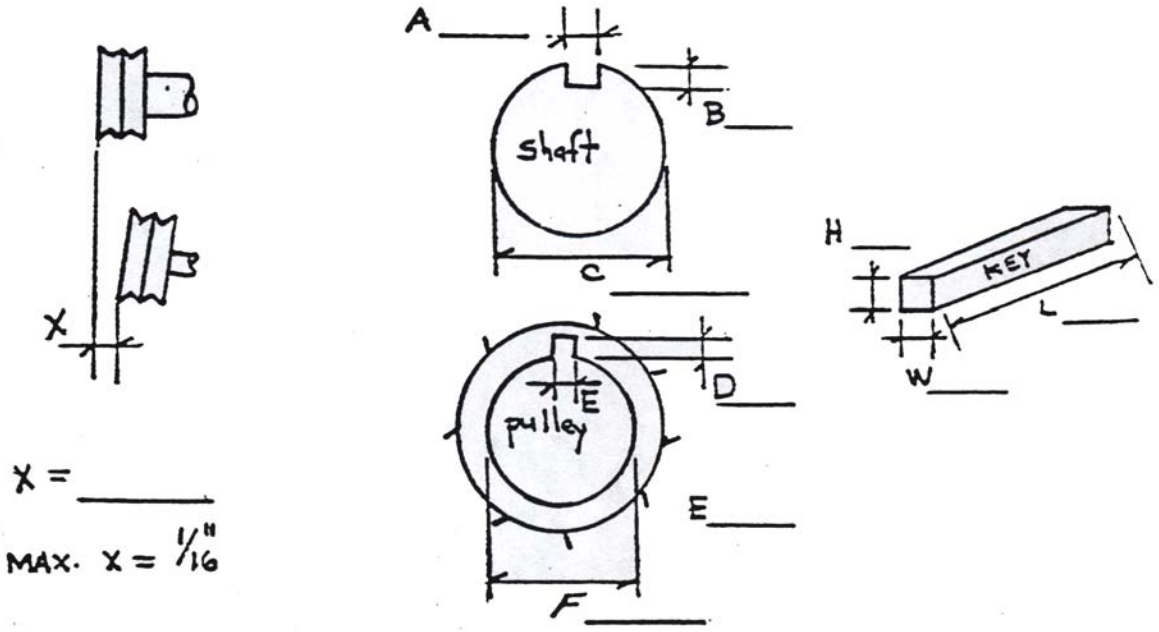
INSPECTION AND RECORDING DATA SHEET
PULLEY ALIGHMENT

Date:_____
Equipment Tag no.:_____
Equipment Description:_____
Drive Horsepower:_____R.P.M.:_____
Pulleys:

	Driver	Driven
Manufacturer:	_____	_____
Type:	_____	_____
Size:	_____	_____

Shaft Center to Center Distance: _____

Belt:
Manufacturer: _____
Type:_____ No. Required:_____
Center Span Force Range:_____ Span Deflection:_____
Are Permanent Supports Installed and Grouted:_____
Is Equipment Final Grouted:_____
Actual Force at Span Deflection:_____



Remarks:_____
_____
Note: Where pulleys are to be field fitted, bore, shaft, keyway and key dimensions are to be measured with micrometers and depth gauges and recorded on this form.
Engineer/Administrator:_____

Contractor:_____

INSPECTION AND RECORDING DATA SHEET

DESIGN CRITERIA – March 10, 1995

State of Utah – DAS – Division of Facilities Construction and Management

COUPLING/GEAR ALIGNMENT

Date:_____

Equipment Tag No.:_____

Equipment Description:_____

Drive Horsepower:_____R.P.M.:_____

Coupling Mfg. & Madel No.:_____ Gap:_____

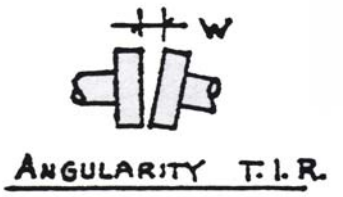
Coupling Lubricant:_____ Date Lubricated:_____

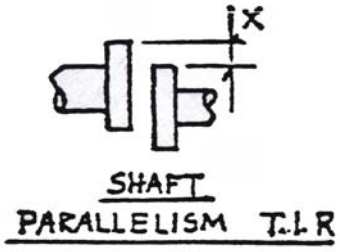
Are Permanent Pipe Supports Installed & Grouted:_____

Is Equipment Final Grouted:_____

Was Pipe Stress Checked:_____

Was a check Made for Soft Feet:_____





	Degrees	W_1	W_2	X_1	X_2	Y_1	Y_2
TOP	0						
	90						
BOTTOM	180						
	270						
TOP	360						

Remarks:_____

_____

_____

_____

To obtain angularity, shaft parallelism and gap – roll coupling halves together all suction and discharge pipe loose (W_1, X_1, Y_1). Repeat with pipe bolted tight without readjusting or zeroing the dial indicator (W_2, X_2, Y_2).

Engineer/Administrator:_____

Contractor:_____

MOTOR AND CONTROL TEST RECORD

JOB NO._____ SHEET____OF ____

OWNER_____PLANT_____UNIT____

SYSTEM NO._____ NAME_____

EQUIPMENT:_____
_____

NAMEPLATE DATA

MOTOR

MANUFACTURER_____ SERIAL NO._____
MODEL NO._____ TYPE_____ DUTY_____
HP_____ VOLTS_____ AMPS_____
RPM_____ FRAME_____ INSULATION CLASS_____
TEMP. RISE_____ AMB._____ SERVICE FACTOR_____
BEARING TYPE_____ BEARING NO. _____
ROTATION VIEWED FROM OUTBOARD END: CW_____ CCW_____

STARTER OR BREAKER

MANUFATURER_____TYPE_____SIZE_____OVERLOAD HTR. NO._____

TEST AND SERVICE DATA (Details on Separate Forms)

MOTOR (Date) (Date)

MEGGER _____ GROUND CONNECTED _____
LUBRICATION _____ ROTAION VERIFIED _____
COUPLING _____ VIBRIATION _____

CONTROLS (Date)_____

STARTER OR BREAKER SERVICED _____
CONTROLS TRIED: DWG. NO._____ REV._____ _____
CONTROLS DEMONSTRATED: DWG. NO. _____ REV. _____ _____
CURRENT TRANSFORMERS TESTED _____
C.T. SECONDARY CONTINUITY TESTED _____
RELAYS CALIBRATED _____

OPERATING DATA (System in Normal Service Condition)

STARTING CURRENT_____ Amps VOLTAGE _____ Volts
RUNNING CURRENT _____ Amps PREPARED BY _____
ACCELERATION TIME_____ Sec. Signed/Date_____

CONTROLS VERIFIED PREPARED BY_____
FUNC. DESC. NO._____ REV._____ Signed/Date_____

COMMENTS:_____
_____
_____
_____

PUMP INSTALLATION CHECK LIST

Job No._____ Location_____ Date_____

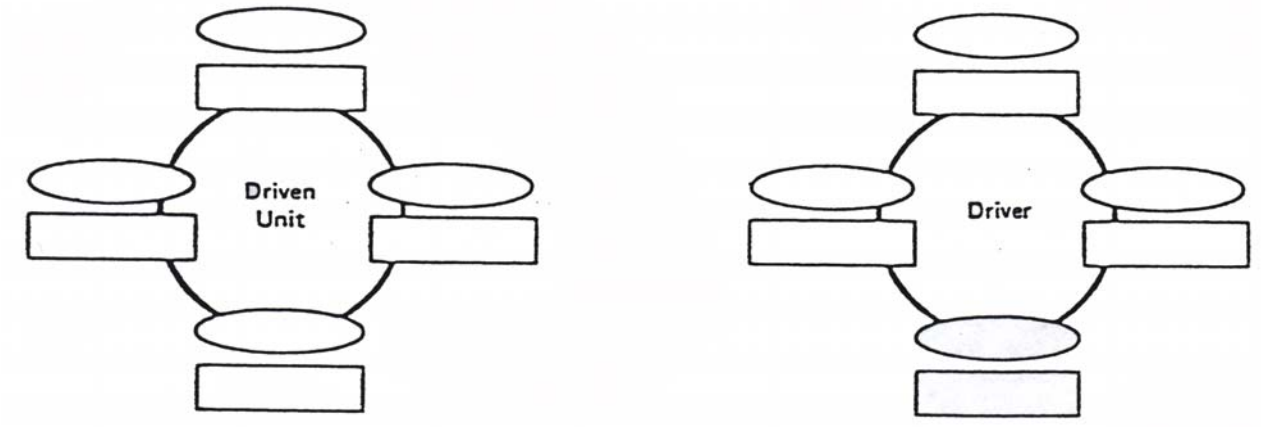
PUMP

Mfr._____ Serial No._____

Pump No._____ Page 1 of 2

Pregrouting Checks and Rough Alignment

1. Is baseplate level? _____
2. Are anchor bolts and nuts tight and protected? _____
3. Has foundation surface been prepared per manufacturer's recommendation?
   _____
4. Do shims meet job requirements and manufactures recommendation?
   _____
5. Have grout pouring or vention holes been provided, if required?
   _____
6. Rough alignment prior to grouting – Use a minimum or 0.020 shims for the driver and the following: Angularity 0.002" Max: axially horiz 0.003" max; ver 0.003" max.



See item 18 for recording instructions

Approval to Grout:	Grouting Accepted By:
DFCM, or Designee	DFCM, or Designee
Date	Date
Vendor (if onsite)	Vendor (if onsite)
Date	Date

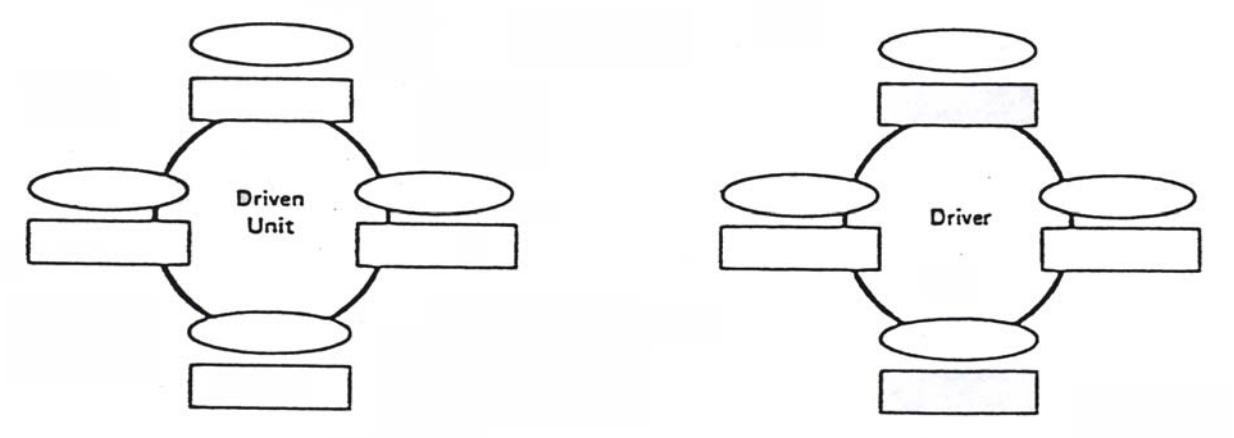
PUMP INSTALLATION CHECKLIST - CONTINUED

Date_____

Pump No._____ Page 2 of 2

Final Checks and Final Alignment

7. Is motor rotation correct? By Electrical
8. Has motor been run-in for approximately on hour disconnected? By Electrical
   Excessive bearing temperature? _____
   Excessive vibration? _____
9. Packing required?_____ Installed? _____ By KMCC, if required
10. Mechanical seal required? _____ Installed? _____
11. Is all pre-service lubrication completed?_____
12. Is pump provided with drain facilities if possibility of freeze up?_____
13. If positive displacement pump, is relief valve provided?_____
14. All auxiliary piping completely installed?_____
15. Are suction screens in place?_____
16. See Item No. 18 for recording instructions.
17. Final Pump and motor alignment (after the piping has been hydro tested). If the manufacturer's tolerances are not given, use the following: angularity 0.002" max; axially horizontal 0.003" max; vertical 0.003" max.



Vertical △ in alignment due to thermal growth_____

18. Instructions for Recording Alignment:
    - Record coupling outside diameter indicator readings in the ▭ and the face reading in the ⬭ .
    - Orient readings in both driven and driver boxes by looking at coupling from driver outboard end.
    - Record driven readings with indicator and driven half of coupling. Then record driver reading with indicator and driver half of coupling.

Final Alignment Accepted By:	Final Alignment Accepted By:	Final Alignment Accepted By:
DFCM, or Designee:	Verification Testing	Customer
Date:	Date:	Date:

DESIGN CRITERIA – March 10, 1995
State of Utah – DAS – Division of Facilities Construction and Management

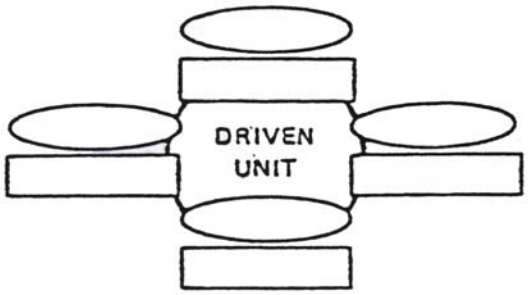
COMPRESSOR INSTALLATION CHECKLIST

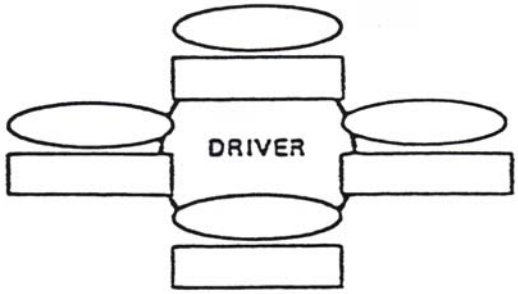
Job No._____ Location_____ Date_____
Compressor No._____ Page 1 of 2

Compressor Service_____ Mfr _____
Type of Compressor_____ Stages_____
Type of Driver_____ Rating_____

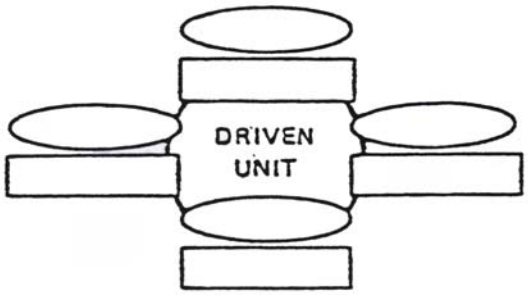
Pregrouting Checks and Rough Alignment

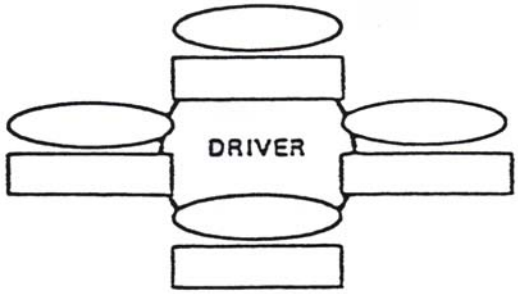
1. Is baseplate level per manufacturer's standards?_____
2. Are anchor bolt nuts tight and protected?_____
3. Has foundation surface been prepared per manufacturer's standards?
   _____
4. Do shims meet job requirements? _____
   Manufacturer's recommendations? _____
5. Have grout pouring or venting holes been provided, if required?
   _____
6. Compressor and driver rough alignment. Use a minimum of 0.020" shims for the driver and the following: angularity 0.002" max; axially horiz 0.003" max; vertical 0.003" max. (See item 15 for recording instructions)





7. For equipment with gearboxes use a minimum of 0.020 shims for the driver and the following: angularity 0.002" max; axially horiz 0.003" mas; vertical 0.003" max. (See item 15 for recording instructions.)





Approval to Grout:		Grouting Accepted By:	
Vendor Representative	Date	Vendor Representative	Date
DFCM or Designee	Date	DFCM or Designee	Date

DESIGN CRITERIA – March 10, 1995

State of Utah – DAS – Division of Facilities Construction and Management

GENERAL RUN IN DATA

MOTOR:ROTATION: CW CCW
(Viewed from end opposite shaft)
.....CONTROLS VERIFIED
OVERLOAD
.....SIZE .....SETTING
.....FUSE RATING
.....RATED MOTOR AMPS

INSULATION RESISTANCE
.....MEGOHMS AT....VOLTS

TEMPORARY SCEENS
LUB OIL: PUMP SUCTION:
.....SIZE .....SIZE
.....MESH .....MESH

INITIAL START
..... NOISE NORMAL
..... VIBRAITION NORMAL
..... CLEARANCES
..... OIL PRESSURE
..... OIL LEVEL
..... OIL FLOW
..... BELT TENSION

RUN-IN DURATION
FROM..... TO.....
.....TOTAL TIME
REACHED STEADY BRG TEMP
.....HOURS .....MINS

SPEED
.....RATED RPM
.....MEASURED RPM
.....TO RPM

INSTRUMENTATION OPERABLE
COMMODITY
.....PRESSURE .....
.....TEMP .....
.....LEVEL .....
.....FLOW .....

AFTER WARM UP
.....GLAND ADJ.
.....BOLTS TIGHT
.....NO RUBS
.....GEAR TOOTH PAT.
.....COOLING WAY
.....SEAL WATER
.....INBOARD BRNG TEMP
.....OUTBOARD BRN TEMP
.....MOTOR TEMP
.....GLAND TEMP

MEASURED AMPS
MINIMUM LOAD:
..... RED
..... YELLOW
..... BLUE

LOADED
..... RED
..... YELLOW
..... BLUE

LOAD COND.
.....

REMARKS: _____

_____

_____

_____ _____

REPRESENTATIVE ENGINEER

DESIGN CRITERIA – March 10, 1995

State of Utah – DAS – Division of Facilities Construction and Management

EQUIPMENT RUNNING HOURS RECORD

JOB NO._____ SHEET_____OF_____

OWNER_____ PLANT_____ UNIT_____

SYSTEM NO. _____ FACILITY _____ WEEK ENDING FRIDAY_____

Equipment	Running Hours							Hour's This Week	Hour's Previous Week's	Total Hours to Date
	Sat	Sun	Mon	Tue	Wed	Thu	Fri			

PREPARED BY_____

Signed/Date_____

COMMENTS:_____

_____

_____

_____

TRANSMITTERS & RECEIVERS

CALIBRATION DATA SHEET

JOB NO._____ SHEET_____OF_____

OWNER_____ PLANT_____ UNIT_____

SYSTEM NO._____ NAME_____

INSTRUMENT NO.

DESCRIPION

TRANSMITTER INPUTS @ SIGNL, PSI

3	3
9	9
15	15
21	21
27	27

RECEIVER READING

3	3
9	6
15	9
21	12
27	15

MANUFACTURER

REMARKS

DATE

CALIBRATED BY_____

Signed/Date_____

POSITION OPERATORS

CALIBRATION DATA SHEET

JOB NO._____ SHEET_____OF_____

OWNER_____ PLANT_____ UNIT_____

SYSTEM NO._____ NAME_____

POSITION OPERATOR NO.

DESCRIPION / Mfr.

INPUT CLOSED, PSI

INPUT OPEN, PSI

PISTON TRAVEL, IN.

DRIVE ARM

RADIUS

ANGLE

QUADRANT

Length of
CONNECTING LINKAGE

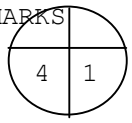
DRIVEN ARM

RADIUS OR STROKE

ANGLE

QUADRANT

REMARKS



DATE

ANGLE ON QUADRANT REFERS TO THE CLOSED POSITION AS VIEWED FROM THE LINKAGE END.
ANGLES ARE MEASURED FROM THE HORIZONTAL. QUADRANTS ARE NUMBERED AS SHOWN ABOVE.

CALIBRATED BY_____
Signed/Date_____

All linear measurements are taken
from center of connecting pins.

DESIGN CRITERIA – March 10, 1995

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CONTROLLER TEST DATA

Project No. _____ Date _____

By_____

EQUIPMENT TAG NO. _____ MANUFATURER _____

LOCATION _____ TYPE _____

RANGE _____

---

1. Calibrated as per instrucution manual procedure:

	DEVIATION		SET POINT SPAN	REFERANCE JUNCTION	OUTPUT
	ZERO	SPAN			
0%					
50%					
100%					

2. Controller left with the following settings:

   a. Set Point _____

   b. Direct or reverse acting

   c. Reset _____

   d. Gain _____

   e. Gain-Reset switch _____

   f. Pre-act _____

   g. Output: Normal or Inverted

   h. Transmitter power _____

   i. Auto or Manual

   j. Remote or Local

   k. Differential gap _____

CONTROL VALVES

CALIBRATION DATA SHEET

JOB NO._____ SHEET_____OF_____

OWNER_____ PLANT_____ UNIT_____

SYSTEM NO._____ NAME_____

INSTRUMENT NO

DESCRIPTION

AIR TO POSITIONER

VALVE CLOSED

VALVE 1/2 TRAVEL

VALVE OPEN

AIR TO DIAPHRAGM

VALVE CLOSED

VALVE 1/2 TRAVEL

VALVE OPEN

NOM. DIA. RANGE

VALVE TRAVEL, IN.

MAUFACTURER

SERIAL NO.

REMARKS

DATE

DIAPHRAGM PRESSURES ARE NO FLOW CONDITIONS. NOMINAL DIAPHRAGM PRESSURES ARE FOR NORMAL FLOW CONDITIONS.

CALIBRATED BY_____

Signed/Date_____

DESIGN CRITERIA – March 10, 1995
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FLOW METER

CALIBRATION DATA SHEET

JOB NO._____ SHEET_____OF_____

OWNER_____ PLANT_____ UNIT_____

SYSTEM NO._____ NAME_____

SERVICE: _____ INCHES OF WATER_____

MAKE OF METER: _____

MAXIMUM METER RANGE: _____

%	In. H2O	Meter	Recor	Indicator	Air Out Put		%	In. H2O	Meter	Recor	Indicator	Air Out Put

COMMENTS:_____

_____

_____

_____

CALIBRATED BY_____

Signed/Date_____

DESIGN CRITERIA – March 10, 1995
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MOTOR OPERATED VALVE

TEST RECORD

JOB NO._____ SHEET_____OF_____

OWNER_____ PLANT_____ UNIT_____

SYSTEM NO._____ NAME_____

EQUIPMENT: _____

NAMEPLATE DATA

VALVE
MANUFACTURER_____ SIZE_____
TYPE: GLOBE_____SOLID DISC_____ SPLIT DISC _____ BUTTERFLY_____
OPERATOR
MANUFACTURER_____ MODEL_____ SERIAL NO._____
VOLTS_____ AMPS _____
STARTER OVERLOAD
MANUFACTURER_____ TYPE_____ SIZE_____ HTR. NO._____

TEST AND SERVICE DATA (Details on Separate Forms)

MOTOR (Date)
MEGGER _____
LUBRICATION _____
PACKING _____
GROUND CONNECTED _____ (Date)
ALIGNMENT _____
CLEANLINESS INSP. _____

CONTROLS (Date)_
STARTER SERVICED _____
CONTROLS TRIED: DWG. NO._____REV._____ _____
CONTROLS DEMONSTRATED: DWG. NO._____REV._____ _____

OPERATION DATA	WITHOUT LINE PRESSURE	WITH LINE PRESSURE
VALVE OPENING TIME	Sec.	Sec.
VALVE OPENING CURRENT	Amps.	Amps.
VALVE OPENING TORQUE SW. ADJ.	Amps.	Amps.
VALVE CLOSING TIME	Sec.	Sec.
VALVE CLOSING CURRENT	Amps.	Amps.
VALVE CLOSING TORQUEW SW. ADJ.	Amps.	Amps
VOLTAGE	Volts	Volts

PERFORMED BY_____
Signed/Date_____

COMMENTS:_____
_____
_____
_____

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HYDROSTATIC TEST RECORD

Contract:_____

Contractor:_____

Facility:_____

System Tested:_____

Limits of Test (Sketch):

Specified Test Pressure:_____

Actual Test Pressure:_____

Length of Pressure Application:_____

Method of Leak Detection:_____

_____

Remarks:_____

_____

_____

Witnessed by (Contractor): _____ Inspector:_____
Date: _____

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PIPE CLEANING RECORD

JOB NO._____ SHEET_____OF_____

OWNER_____ PLANT_____ UNIT_____

SYSTEM NO._____ NAME_____

LINE DESCRIPTION	CLEANING MEDIUM	FLUSH STEPS	COMPLETED

COMMENTS:_____
_____
_____
_____

PERFORMED BY_____

Signed/Date_____

DESIGN CRITERIA – March 10, 1995
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Facility Hoists and Bridge Crane – Inspection & Tests

DATE:_____ RATED CAPACITY: Main Hoist_____

Auxiliary Hoist_____

EQUIPMENT NO.:_____ MFR. SERIAL NO.:_____

TYPE OF CRANE:_____ MANUFACTURER:_____

POWER SUPPLY:_____ VOLTS:_____ PHASE:_____

LOCATION:_____

_____

INSPECTION Initial Acceptance_____

And Load Test: Periodic _____

Type:_____Repairs/Alterations_____

_____

_____

_____

STATIC TEST (Load Wgt.): Main Hoist_____ Auxiliary Hoist _____

DYNAMIC TEST (Load Wgt.): Main Hoist_____ Auxiliary Hoist _____

LOAD TEST PERFORMED BY:_____

LOAD TEST INSPECTED BY:_____

Deflection at Central Lift Point:_____

Comments:_____

_____

_____

_____

_____

_____

WITNESS:_____ WITNESSED BY:_____

Attachment I:

Inspection Checklist

HOIST AND CRANE INSPECTION CHECKLIST

			Satisfactory	Unsatisfactory & Explanation
HOIST	MAIN HOIST	Brakes/Drums		
		Speed		
		Limit Switches – Upper		
		Limit Switches – Lower		
		Block		
		Sheaves		
		Running Rope/Chain		
		Dia. Rope – New		
		Dia. Rope – Now		
		Reach Chain – New		
		Reach Chain – Now		
	AUX.HOIST	Brakes/Drums		
		Speed		
		Limit Switches – Upper		
		Limit Switches – Lower		
		Block		
		Sheaves		
		Running Rope/Chain		
		Dia. Rope – New		
		Dia. Rope – Now		
		Reach Chain – New		
		Reach Chain – Now		
HOOKS	MAIN HOOK	Magnetic Particle/Liq. Penetrant		
		Spreadset and Wear		
		Safety Latches		
		Fastening Devices		
	AUX. HOOK	Magnetic Particle/Liq. Penetrant		
		Spreadset and Wear		
		Safety Latches		
		Fastening Devices		
CAGE OR CAB		Housekeeping		
		Weld, Bolts, Members		
		Warning Device		
		Main Breaker Switch & Reset Switch		
		Wiring and Interlock Switches		
		Fire Extinguisher		
		Escape Device		
CONTROLLERS		Trolley		
		Bridge		
		Main Hoist		
		Auxiliary Hoist		
BRIDGE		Bridge Structure		
		Runaways and Wheels		
		Speed		
		Shafts, Bearings and Gears		
		Guards and Bumpers		
		Brakes		
		Main Conductors		
		Collectors and Slides		
		Resistors and Insulators		
		Control Panels		
TROLLEY		Bearings and Gears		
		Wheels		
		Nails		
		Railstops		
M.		Make		
		Model		

Registration Number
Safe Working Load

DESIGN CRITERIA – March 10, 1995

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HVAC DATA SHEET

EQUIPMENT:

MAKE_____ MODEL_____ SERIAL_____ FILTERS LOCATION_____

BLOWER SECTION_____
CONDENSER SECTION_____
COMPRESSER:_____

MECHANICAL CHECK LIST

Pulley Align & Set Screws Tight on
Motors
Blower Wheel
Power Prop
Belt tension Set on in & outdoor Unit
Unit Oiled Properly
Are fans vibrating or noisy?

ELECTRICAL CHECK LIST:

Tighten all electrical connections
Motor Starters
Start Relay
Fan Relays
Capacitors

Unit Voltage	Running
Pump AMP Rated	Operating
Comp. AMP Rated	Operating
Indoor Fan AMP Rated	Operating
Condenser Fan AMP Rated	Operating
Combustion Fan AMP Rated	Operating

Correct rotation of Blowers and Pumps
Indoor Fan RPM

HEATING CHECK LIST

Furnace Fan Control Set	On
Furnace Limit Control Set	Off
Thermostat	Set

REFRIGERATION SYSTEM

Comp. Ship. Brackets Removed	
Discharge Pressure	
Suction Pressure	
Temp, Drop Across Indoor Coil	Entering
S.P. Entering Unit	Leaving Unit
Outdoor Air Temp	Conden, Discharge Temp.
Super Heat	
High Pressure Cutout	Cut-in
Low Pressure Cutout	Cut-in

SYSTEM OPERATION CHECK

Air Balancing Satisfactory:
Does unit operate on controls
Thermostat Calibrated & Operation check
Is sticker on unit?
Supply & Return registers checked & unobstructed
Drain Line Clear & to approved receptor
Tenant instructed in operation

Remarks:_____
_____
_____
_____
_____

Serviceman_____
Signature Representing Date

Contractor_____

SECTION 6 ELECTRICAL

DIVISION 16 Electrical

6.1 Workmanship: All workmen doing electrical work of any nature on State of Utah project must at all times carry their electrician's license with them and show it upon request.

6.2 Industry Standards: See Section 1.0 of the Design Criteria for applicable codes and related publications.

6.3 Regulations, Inspections:

A. Design for all projects shall comply with all regulations in effect that apply to the electrical installations and in accordance with NEC and this document. Conflicts shall be brought to the attention of Fee Architect/Engineer.
B. Before final acceptance of this work a DFCM representative shall test all wiring systems with the assistance of the architect and electrical consultant's representative, with all lamps, motors, appliances and equipment in place and in good working condition. The entire construction shall test free of mechanical and electrical defects.
C. All materials shall be new and shall bear the manufacture's name, trade name and the approved testing laboratory such as UL label in every case where a standard has been established for that particular material.
D. Shop Drawings: A set of approved shop drawings will be given to the institution. Another set of approved shop drawings will be maintained at the job site, with a complete set of drawings that detail the construction project. This set shall be marked daily during construction to show any changes or deletions in the scope of the project.
E. Prerequisite for electrical final inspection:

1. Electrical engineer/consultant must be present.
2. Electrical contractor job foreman must be present.
3. DFCM electrical specialist must be present.
4. Fire alarm manufacture representative must be present.
5. Fire Marshal or his representative must be present.

Electrical System:

1. Main panel/switchboard shall be open.
2. Clear access shall be provided to all device and equipment.
3. All M.C.C. units, starter combination units shall have a chart indicating heater type - size and rating.
4. 4. All panels and disconnects shall be labeled per plans and specifications with typed index cards indicating specific circuit locations and use.

DIVISION 16 Electrical

5. All light fixtures shall be on and operating.
6. Electrical contractor shall have pad and pencil to list all deficient items noted.
7. All corrections and adjustments shall be done after the inspection, not during. These items will appear on the final inspection punch list.
8. Required keys for panels and doors.

Fire Alarm System:

1. Complete system must be put on battery power no less than 24 hours, or longer as specified, prior to final test but in no case less than 24 hours.
2. Two-way radios, approved type of smoke as recommended by the manufacturer and hair dryer (or other means to set off heat detectors) and 3 K ohm resistor to test ground fault shall be provided by electrical contractor or fire alarm system representative.
3. Each detector shall be tested and each zone shall be opened to test class A loop and ground fault.
4. Each zone shall be identified by specific location on the panel.
5. All Fire Alarm system junction or pull boxes shall be identified with zone number and red paint.
6. Fan shut down, sprinkler flow and tamper switches, door closers and all other devices shall be completed and operational.

6.4 Temporary Electric Services:

A. The General Contractor doing the work will make arrangements with the proper institution authority for all temporary utilities, including electricity.

B. Provide temporary power, complete with metering and wiring for lighting and power outlets for construction tools and equipment. Report the initial meter reading to the institution, or otherwise as may be directed.

C. Service shall be provided with a main disconnect and all 20 ampere receptacles protected by 20 amp GFI, single-pole. All temporary wiring shall meet NEC, Article 305, requirements. No attempt is made herein to specify construction power requirements for equipment in detail.

D. As soon as permanent power and metering is available, the temporary power supply shall be disconnected and removed from the construction site.

SECTION 6 ELECTRICAL

DIVISION 16 Electrical

6.5 Excavation: Trenching or other excavation necessitated shall include proper backfilling, compaction and grading of excess earth. All rubbish or waste shall be removed and premises left clean as far as construction is concerned. See Raceways, Item No. 6.8.

6.6 Utility Interruption: Any electrical service interruption will be coordinated at least 7 days in advance of the power shutoff.

6.7 Basic Materials and Methods:

A. All wiring shall be concealed, except at surface-mounted panels and apparatus (See Raceways for type of materials and additional information).

B. Labeling: Engraved black plastic laminated, with white-core labels, 1/16" thick, shall be permanently attached on the interior and the exterior of branch panels and the exterior of disconnect switches, motor controls major J-Boxes (power and auxiliary), push buttons, thermal switches, time switches and similar equipment. The labels shall have 1/4" high, engraved letters, such as 1 1/2 HP Fan, Panel A, plus heater size and F.L.A. The phase of each feeder conductor shall be colorcoded at each end, in panels and junction boxes.

6.8 Raceways:

A. Electrical conductors shall be installed in approved electrical raceways of sizes and type required by the NEC and specifications to accommodate the number of conductors. Electrical conduit may be:

1. Metal Conduit: Minimum-size conduit used for any purpose for electrical wiring shall be 3/4" EMT, Rigid, or IMC. One-half inch EMT may be used for low voltage control circuits only. Conduits are to be strapped within 12 inches of couplings, fittings and boxes, minimum of two straps per ten foot run. Each run shall be strapped at each 90 degree bend.
2. Plastic conduit (PVC) (Polyvinyl Chloride) may be used where branch circuits, primary or main feeders are run underground, they may be red concrete encased. No PVC allowed above grade nor penetrating structural elements. Any underground or buried bends greater than 22 degrees shall be PVC wrapped rigid metal. Conduit through floor, concrete and/or earth and shall be wrapped with PVC tape or other approved coating.

SECTION 6 ELECTRICAL

DIVISION 16 Electrical

B. Conduit Ends:

1. Field bends and offsets shall be made without flattening, kinking, rippling or destroying the smooth internal bore or surface of the conduit and to not less than NEC minimum radius. Conduit that shows signs of rippling or kinking shall not be installed.

C. Steel Conduit:

1. Flexible steel/conduit in short lengths shall be used where movement, vibration, misalignment or cramped quarters exist. Commercial "greenfield" not less than 1/2" diameter may be used in dry locations. For wet, humid, corrosive or oily locations, the liquid-tight flexible conduit enclosed in a synthetic rubber or neoprene jacket shall be used together with approved moisture-tight fittings.
2. A ground conductor shall be installed in each flexible conduit run of more than 6' in length.

D. Flexible Conduit:

1. Aluminum flexible conduit shall not be used.

E. Fittings:

1. The use of indenter-type fittings shall be prohibited. Die-cast fittings shall not be allowed on any conduit run of any size conduit.
2. Box connectors 1" and larger shall be insulated, throat-type or equal type plastic bushing.
3. Double lock nuts and plastic bushing shall be used with all IMC and rigid conduit.
4. Grounding bushings will be used on all service conduit and conduits installed in concentric/eccentric knock-outs or reducing washers.
5. Conduit bodies shall not contain splices.

F. Concealed Conduits:

1. Conduits shall be run concealed in all finished area, but may be exposed in unfinished areas, where so indicated or when permitted by approval of the Architect.
2. Concealed conduits shall be run in a direct line and with bends as long as possible.
3. Conduits shall not be installed closer than 12" to any hot water or steam line, measured from outside of insulation.

G. All direct buried conduit in an area outside a building shall be not less than 24" deep, with magnetic "Yellow Warning" ribbon 12" directly above and 6" below finished grade measured from the top of the conduit or duct bank.

H. Fire alarm systems, sound systems, TV antenna, communication, & HVAC systems wire or any system which complies with NEC Article 725 are required to be in conduit and shall be permitted in 1/2" conduit or larger.

I. All wiring shall be installed in approved raceways. Electrical metallic tubing may be used except where installed in earth, concrete slabs adjacent to earth, or in areas subject to mechanical injury. EMT may be used in concrete slabs above grade level. NO ALUMINUM CONDUIT WILL BE ALLOWED ON STATE PROJECTS.

J. In general, all raceways shall be concealed within the ceiling, walls, and floors, except in locations where exposed raceways are specifically permitted, such as in equipment rooms and unfinished storage areas. In equipment rooms, if lighting raceways are run exposed, installation shall not be done until piping and duct work layout has been determined in order that lighting outlets may be located so as to avoid being covered by overhead ducts and pipes. If lighting raceways in equipment rooms are concealed in the structural ceiling slab, after mechanical work is completed, exposed conduit extensions shall be run to locate lighting fixtures where they are not obscured by work of other trades. Flexible steel conduit may be used where required for ease of installation.

K. Precaution shall be exercised to prevent accumulated of water, dirt or concrete in the conduits during the execution of the project. Conduits in which water or foreign matter has been permitted to accumulate shall be thoroughly cleaned or the conduit runs replaced where such accumulation cannot be removed by methods approved by the Architect's Project Engineer.

L. Conduit, tubing and boxes shall be supported in an approved manner by means of expansion shields or other approved anchors in concrete or solid masonry, toggle bolts, on hollow masonry units, wood screws or wood and metal screws on metal. Wooden plugs inserted in concrete or masonry units shall not be used as a base for fastening conduits, tubing, boxes, cabinets, etc.

M. Any conduit which pierces airtight spaces or plenums shall be sealed to prevent air leakage with a mastic acceptable to the Architect.

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N. Conduits which pierce roof shall be flashed under this Section of the Specifications in accordance with applicable other sections. Flashing shall be done under the direct supervision of the subcontractor responsible for flashing.

O. Install accessible junction boxes or condulets in conduit runs as required at 100-foot intervals on long runs. Each junction box shall be supported independent of the conduit.

P. The open ends of empty conduit shall be capped to keep out debris until the project is completed.

Q. Install, from each branch panel, five spare 3/4" conduits (capped) into the ceiling and floor space from each panel. When the floor space is not accessible, run six into the ceiling.

R. All empty conduit shall be left with a 200-lb nylon pull cord installed and capped.

S. All holes cut in fire-rated structures shall be properly sealed with materials that will provide the same fire rating.

6.9 Conductors:

A. Phase Conductor

1. Minimum-size phase conductor shall be copper No. 12 with 600 v insulation.
2. Under NO CONDITION shall conductors less than #1/0 copper be run in parallel; in all cases parallel runs must be cut to exact length on each phase leg. Where parallel conductors are run in parallel conduits, each conduit shall carry all phase legs and neutral and ground conductors if required. A full sized ground shall be installed in all paralleled conduit.
3. The conductor insulation shall be THW, THHN, XHHW unless otherwise indicated. Conductors used for branch circuits in areas where the ambient conditions exceed 30 degree C. shall be wired with an insulation approved for that temperature.

B. All underground wiring shall in all cases be run in conduit. The use of UF or URD type wiring without conduit for buried runs shall only be permitted by special permission.

C. To standardize electrical construction on State of Utah projects, the following color code shall be followed for branch circuits:

120/208 V 3-Phase 4-Wire	Above 1000 (1KV)
L-1--Black	L-1--Black
L-2---Red	L-2--Red
L-3--Blue	L-3--Orange
Neutral--White	Neutral--White
Ground--Green or Bare Copper	Ground--Green or Bare

277/480 Volt 3-Phase 4-Wire

L-1--Brown
L-2--Orange
L-3--Yellow
Neutral--Gray
Ground--Green or Bare Copper

120/240 Volt 1-Phase 3 Wire

L-1--Black
L-2--Red
Neutral--White
Ground--Green or Bare Copper

D. All combinations shall be color coded by the above color reference. Switch legs, travelers and other wiring for branch circuits shall be of colors other than those listed above.

E. Fixture Conductors: Conductors run in fluorescent fixture channels shall be Type THHN.

6.10 Fittings:

A. Compression or set screw-type (screws must have a full set) connectors and couplings used on EMT shall be steel. CAST OR INDENTER TYPE FITTINGS ARE NOT ACCEPTABLE. Fittings in concrete shall be compression type and taped or approved for such use.

B. Raceway expansion fittings shall be installed on all raceway runs that cross a building expansion joint. The fittings shall be OZ type "AX" or approved equal, sized to the raceway.

C. Conduits 1" and larger install OZ type "B" connectors.

SECTION 6 ELECTRICAL

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6.11 Outlet Boxes:

A. General: Boxes shall be galvanized or cadmium-plated sheet steel type of the class required to satisfy the conditions at each outlet, unless indicated. Study the building conditions and materials surrounding each outlet prior to installing such boxes to prevent interference with work of other trades. Minimum outlet and switch box shall be 4 x 4 x 1 1/2. Gangable boxes shall not be used.

B. Install boxes with rigid supports using metal bar hangers, or 2" x 4", 1" x 6" wood bridging between studs with screws. Welding boxes directly to metal joist and studs is NOT acceptable. Boxes set opposite in wall shall have at least 10" of conduit between them.

C. Ceiling fixture outlet boxes shall be 4-inch minimum. Each box shall be supported independently of the conduit to carry 200 lbs. Where three or more raceway entrances are made, use minimum box depth of 2 1/8". Where fixtures are to be installed, provide with standard 3/8" stud.

6.12 Boxes - Junction and Device:

A. Junction boxes shall be not less than 4 - 0, with plaster ring and flush with finished surface; 4-S or 4-0 boxes shall be used for all devices, single or double gang, with proper plaster ring and covers. Industrial, raised covers shall be used for switch and outlets run on surface. Boxes shall be securely fastened to the surface with approved anchoring means; wooden plugs shall not be allowed. J-boxes with 4 or more conduits shall be minimum size of 4 11/16".

6.13 Devices:

A. All switches and self-grounding receptacles shall be specification grade, 20 amp minimum; match the finish or decor specified.

B. Mounting Height:

Switches--48" to bottom of device box above finished floor.
Outlets--16" to bottom of device box above finished floor.
Outlets in Garage--18" to the bottom of the device box except commercial garages.

EXCEPTION: Heights may be changed to allow installation above bond beams or counters.

The above mounting heights are minimum standard and may vary according to plans and specifications for special usage. Garage outlet may be mounted higher than the 18" but under no condition less than the specified 18" minimum.

C. GFCI will be provided for all restroom outlets and outlets installed outdoors. This requirement is for all types of State buildings regardless of use or occupancy. Any outlet within 6' of any sink regardless of use shall be GFCI protected.

EXCEPTION: Hazardous location. Articles 500 through 516 shall apply.

D. Receptacles: Shall be installed on individual branch circuits. A maximum of eight (8) 20-amp receptacles shall be installed for each 20-amp single pole breaker.

E. Wall switches shall be specification grade, rated 20-amp, 125/277V volt, located as indicated on the drawings, arranged singular or in gangs and shall be located on strike side of door openings.

F. All floor receptacles shall include carpet or tile flanges and be complete.

G. Convenience outlets in corridors to be Lexan or Nylon with Lexan, or Nylon coverplate, or may be the same type as specified in the rest of building.

H. Blank four-square boxes shall be covered with a matching cover. It should be mounted with two mounting strips.

I. Switch, telephone and receptacle outlet boxes: Not less than 4" square, with adapting tile or plaster covers where necessary to set FLUSH with the finished surfaces. Where three or more conduits entrances are made, use minimum box depth of 2 1/8'. A gang box shall be used where more than one switch or device is located at one point. Sectional boxes are not acceptable. In masonry wall where a tile or plaster ring cannot be used, install a single gang 3 1/2" deep box minimum, unless otherwise noted.

J. Standard or special outlet boxes shall be installed where required.

K. Duplex floor outlet boxes shall be adjustable concrete-tight, with all fittings to suit the floor type and device.

SECTION 6 ELECTRICAL

DIVISION 16 Electrical

6.14 Floor Duct Systems:

A. Provide and install floor duct as per the manufacturer's instructions. The duct shall include all fittings.

B. Single duct shall be complete with couplings, supports, plugs, junction boxes, etc., for a complete system.

C. Double duct shall be complete with couplings, supports, plugs, junction boxes, etc., for a complete system. From the auxiliary side of the double duct, install conduit to wall J-Boxes.

D. Service fittings shall be installed where required and shall be complete with locking nipples, installed as per manufacturer's recommendations.

E. Conductors shall be installed into all "J-Boxes" and service fittings. Where service fittings are not indicated, conductors shall be looped full length of all duct and terminated in J-Boxes for future connections with ends capped and taped with proper identification as to where they feed or terminate.

6.15 Electrical Supporting Equipment:

A. General:

1. Installed anchors must support in tension a minimum of 4 times the weight of the unit supported. A minimum of 100 pounds is required for all anchors. Threaded rods, bolts, etc. are acceptable if they meet the anchorage and unit weight requirements. In all cases bracing shall be parallel to trusses, beams, joist, bridging, etc.
   NOTE: Drilled in anchors of any type shall not be installed in prestressed or post-tensioned concrete slabs and beams without prior approval.
2. Electric equipment including but not necessarily limited to transformers, switchgear, panelboards, generators, battery racks, motors, large conduit racks, 2 inch conduit runs and larger, telephone switchboards, or other heavy electrical equipment shall meet the seismic requirements for the proper seismic zone.
3. Extend all concrete pads 6 inches beyond the largest dimension of the equipment. Equipment pad shall extend a minimum of 3 inches above finished floor or grade.

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B. Conduit, when suspended shall be supported independent from all other eletrical or mechanical systems, directly from building structure, i.e. roof trusses, beams or upper floor joists etc., by means of approved supporting devices, complying to all support tension criteria as outlined.

C. Toggle bolts, moly bolts or screws in sheetrock or plaster or tie wire are not acceptable as a support means for any equipment.

D. Fixtures mounted in or on grid type ceiling shall be safety-wired to building structure at two diagonal corners of fixture to meet seismic requirements for building location and area. Support wires are not to be fastened to grid hangers or grid hangers point of support. The wires must be mounted to building structure i.e.: joist or truss.

E.

Number Runs	3/4" to 1 1/4"	1 1/2" and Larger
1	Full straps, clamps or hangers	Hangers
2	Full straps, clamps or hangers	Mounting channel
3	Mounting channel(trapeze)	Mounting channel

6.16 Electric Service Metering:

A. Where providing and installing an electric service to the facility, include in the base bid any cost assessed by the serving utility to provide an electric service.
B. The service conduit shall be installed under regulations of the service utility as to weatherhead location.
C. The service metering shall be as per the local service utility.
D. Temporary lighting and power will be installed per NEC 305 A and B. Confirm location of pole, transformer pad, size and clearance with the local power company.
E. Provide and mark multiplying factor on meter face where current transformers are used and meter is not furnished by the serving utility. A demand register will be provided also.

6.17 Electric Transformer Connections:

A. Provide and install the lugs, cable, labor and all other materials necessary for the connection of the service power or transformers for the building, including both primary and

secondary where required. The voltage at the main disconnect shall be measured and taps adjusted if necessary to obtain the proper value. All transformers will be furnished with standard taps.

6.18 Grounding:

A. The main service entrance shall be grounded to the metallic water main and one of the following: (A 5/8" x 10' ground rod to be used at transformer only-other locations a ground rod may be used as a second point of ground).

1. The metal frame of the building where effectively grounded.
2. Concrete encased steel reinforcing bar or rod systems or underground footings or foundations where the total rod length, diameter, and depth below earth surface are not less than 50 feet, 3/8 inch and 2 1/2 feet, respectively. The required length shall be made up of one or more rods.
3. Not less than 20 feet of bare copper conductor not smaller than #6 encased in concrete at or near the bottom of a concrete foundation footing in direct contact with earth, 3/8" steel reinforcing bar or rod encased by at least two inches of concrete and located within and near the bottom of a concrete foundation footing that is in direct contact with the earth.

B. Separate neutrals shall be installed on all GFI breakers and GFI outlets.

C. All service entry conduit shall use bonding type bushings where threaded bus are not available.

D. Conduit Systems and Neutral Conductor:

1. The conduit systems and neutral conductor of the wiring systems shall be grounded at the main service disconnect.
2. Connection to water piping system shall be made electrically continuous by connecting to the street side of the water main valve and/or installing additional bonding jumpers across the meter, valves or service unions that might be disconnected.
3. Primary and secondary equipment and circuits or combinations thereof in Transformer Rooms shall be effectively bonded and permanently grounded.
4. Remodeling: Any remodel in affected areas work shall be brought to current NEC requirements and these criteria.

E. System Neutral Conductor:

1. The system neutral conductor shall not under any circumstances be grounded after it has once been grounded at the service entrance disconnect except for separately derived systems. All grounding systems shall be interconnected and/or bonded to the main system ground.
2. Main grounding conductors generally may be run exposed and not be enclosed in a metallic enclosure or conduit. Where mechanical protection and/or concealment is required, non-metallic electrical conduit may be used. Exposed PVC shall be schedule 80.
3. A separate green or bare grounding conductor shall be enclosed with the phase conductor in non-metallic and flexible metallic raceways.
4. The neutral conductors shall not be used for equipment grounding and the neutral bar shall not be grounded to the distribution cabinets.

6.19 Panelboards:

A. Panelboards shall be a standard product of established manufacturers, and shall conform strictly with NEMA standards. They shall be deadfront, bolt-in breaker type, safety type and shall have bus bars with main circuit breakers or appropriate lugs for attaching feeder and/or sub-feeder conductors. Provide ground bus in all panelboards.

B. Cabinets shall be of Code gauge sheet steel, complete with trim, locking doors and three keys; all locks to be keyed alike. Top, bottom and side gutters shall be ample for the feeder conductors to be installed. An approved holder with typed index of all circuits and spares shall be provided on the inside of each cabinet door.

C. Panelboards shall not be used for junction or splicing boxes or as a raceway.

D. All panelboards and panels shall be sized for proper AIC rating as required for safe and proper operation.

E. Panelboards shall be so wired that on a delta three-phase feeder or service, the high leg with proper color code is connected to the CENTER bus.

F. All ground wires (Green or bare Copper) shall terminate on a separate ground terminal strip approved for its use and bonded to the cabinet.

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6.20 Main Power Panel:

A. The equipment shall bear the manufacturer's nameplate and the underwriter's label. All devices shall be UL listed and meet the latest NEMA Standards Publication. All main panel circuits shall be identified. Bus bracing to match short circuit rating of breaker or higher.

B. The main panel switchgear or motor control centers located in Mechanical Rooms shall be mounted on a 4" high concrete base (conform size with shop drawings). Highest disconnect/breaker shall not exceed 6'6" from the top of the throw to the floor. Steel conduits shall have grounding type bushings or plastic bushings in the case of PVC conduit.

C. All breakers in the main distribution panel shall have sufficient interrupting capacity to safely interrupt the available short circuit current from the transformer bank. The main circuit breaker shall have trip ratings with a minimum symmetrical interrupting capacity, as calculated for the system. All AIC calculations will be submitted to DFCM and indicated on Drawings submitted for approval.

D. Feeder breakers shall limit the fault (let-through) current to calculated values.

E. Bracing of bus within main panel shall be integrated with the short circuit characteristics of the breakers contained therein.

6.21 GFP Requirements:

A. All overcurrent devices rated over 150 V to ground and 1000 amps or more shall be protected by ground protection. Current in all phase conductors shall be monitored by the GFP device.

B. The setting of the GFP will be done by a representative of the equipment supplier after equipment has been installed. A complete record of current trip level and time required to trip the disconnecting device shall be submitted to DFCM.

6.22 Branch Panels:

A. Branch breakers shall be automatic thermal-magnetic circuit breaker type and shall be one, two or three-pole, with a common handle of voltage rating and rated for available fault current rating.

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B. All breakers shall be bolted line connections. No plug-in type breakers will be permitted. The notation "BLANK" denotes drilled bus, hardware and space ready to receive future breakers as indicated.

C. The panelboard bus assembly shall be enclosed in a steel cabinet. The size of the wiring gutters and gauge of steel shall be in accordance with the latest NEMA Standards Publication and latest UL Standards for panelboards. The box shall be fabricated from galvanized steel or equivalent rust-resistant steel. The flush locks shall not protrude beyond the front of the door. All panelboard locks shall be keyed alike. Fronts shall have adjustable indicating trim clamps, which shall be completely concealed when the doors are closed. Doors shall be mounted by completely concealed steel hinges. Fronts shall not be removable with door in locked position. A circuit directory frame and card, with clear plastic covering shall be provided on the inside of the door. The directory cards shall by typewritten to identify each circuit service. Use final building room numbers for directory (not architectural room numbers as shown on the plans). Also, record Owner's room numbers on the "Record Drawings".

D. Panel Assembly: The circuit breakers shall be in the same sequence and labeled as the panel schedule on the Drawings.

E. Panels shall not be located behind room doors (Hinged Side).

6.23 Electrical Power Equipment and Clearances:

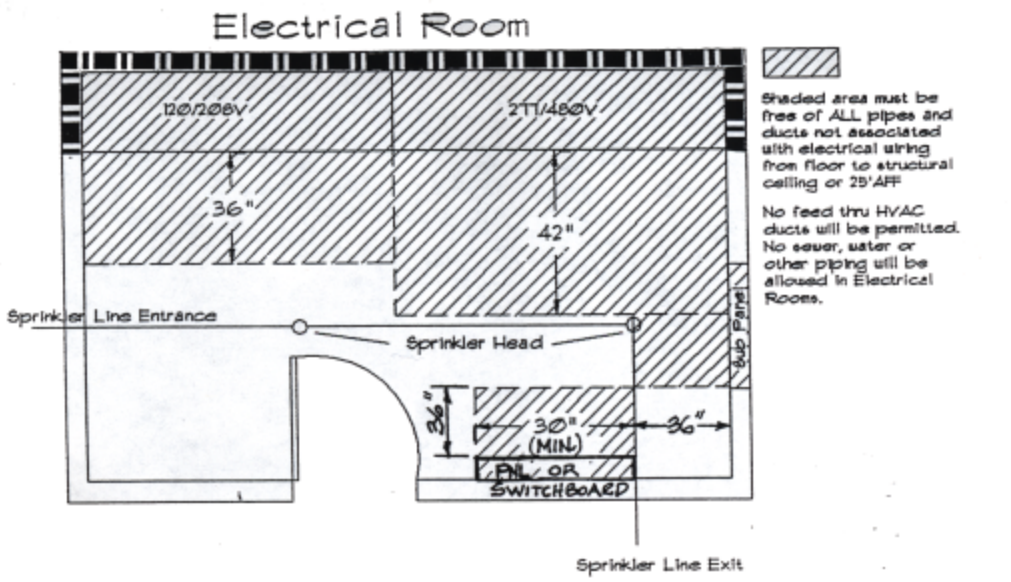
A. Wiring for Mechanical Equipment: Provide power wiring complete to all mechanical equipment.

B. Pressure switches, thermostats, solenoid valves, damper motors and similar equipment will be supplied, and installed under the Mechanical Division.

C. Submit with the record drawings a record of the motor amperage readings of each electrically-driven unit; show horsepower, full-load amps and service factor. Show same on MCC unit labeling.

D. Motor Disconnects: All motors shown on the Drawings shall be equipped with non-fused disconnects or as required by NEC.

E. See Figures 6.1 and 6.2 for panelboard clearance requirements in electrical rooms.



NEC384-4 permits a sprinkler line to enter or pass through an electrical room but not through the dedicated space required by NEC110-16. An electrical room is a room dedicated exclusively to house electrical panels/ switchboards. The dedicated area extends from the floor to the structural ceiling. Dropped ceilings, suspended ceilings and similar ceilings not intended to add strength to the structure are not structural ceilings.

FIGURE 6.1 PANELBOARD CLEARANCE FOR ELECTRICAL ROOM

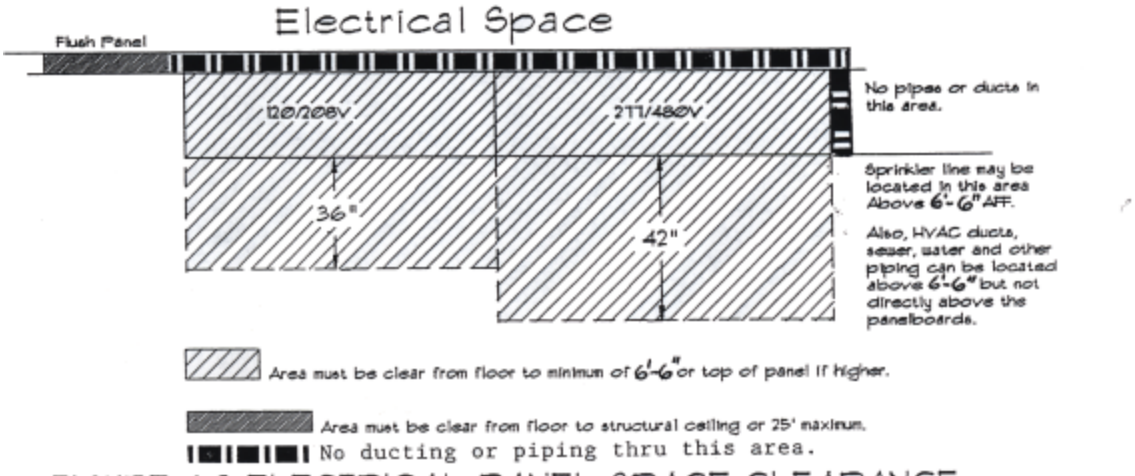


FIGURE 6.2 ELECTRICAL PANEL SPACE CLEARANCE

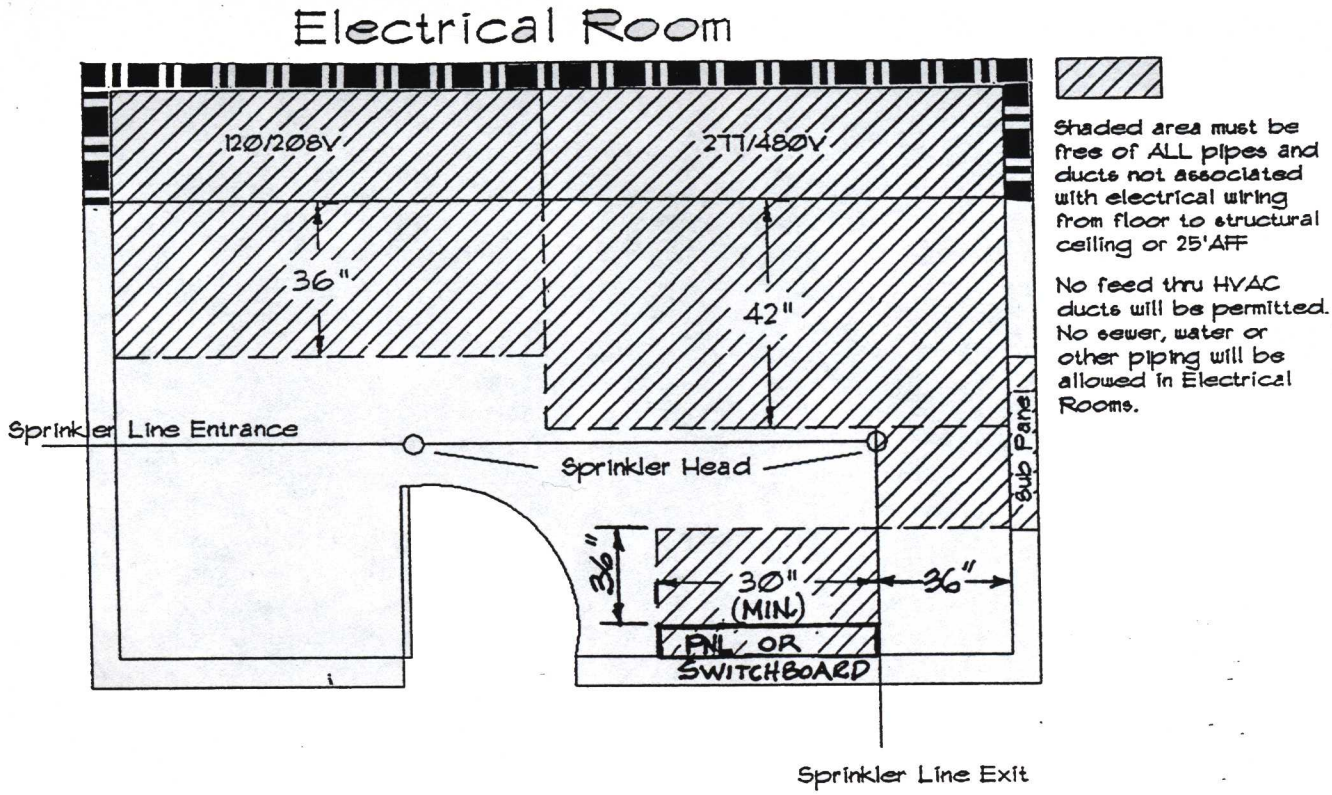


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FIGURE 6.1 PANELBOARD CLEARANCE FOR ELECTRICAL ROOM

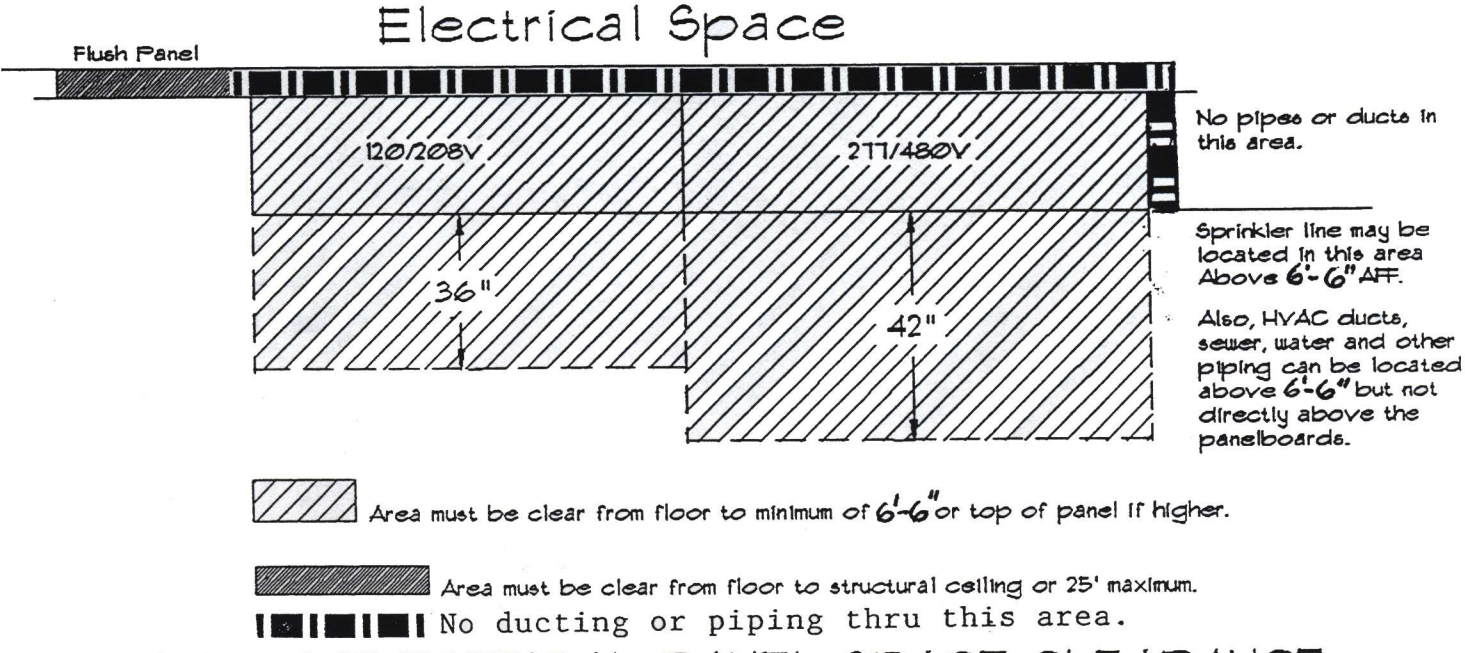

FIGURE 6.2 ELECTRICAL PANEL SPACE CLEARANCE

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6.24 Equipment Identification:

A. Electrical equipment shall be identified by engraved label name tag and/or sign, permanently attached and in such positions as to be visible from normal viewing angles. Letters shall be of such color as to contrast with the background finish of the equipment.

B. Panelboards Identification:

1. Panelboards shall be identified with the symbol shown on the Drawings on the exterior trim, visible without opening the door and on the panel face inside the door. This latter shall also identify the feeder circuit.
2. All subpanels shall be labeled to identify the main panel that supplies the feeder circuit.
3. All circuit breakers shall be labeled to identify the location of the subpanel or equipment supplied, together with the location of the subpanel or equipment using room numbers.

6.25 Motors and Controls:

A. Factory-wired package units, control panels and other equipment shall be connected with adequate capacity and external wiring to complete all essential interlock and control circuits for related auxiliary equipment and devices.

B. Unless otherwise required, motor starters shall be in line voltage, automatic type, with thermal overload relays for each phase, necessary auxiliary contacts for inter-locking purposes, and reset and start-stop pushbuttons in the covers.

C. Thermal protective devices (heaters) for all motors shall be verified and corrected, if necessary, under operating conditions after completion of the installation. A tabulation listing the nameplate current rating of each motor, its measured running amperes, and the size heater element installed in each starter shall be placed on each unit.

D. Each motor shall be connected to the conduit with a length of flexible, sealtight conduit (minimum 18"), with proper type fittings. All motor supply circuits shall include a green or bare ground conductor. Check for proper motor rotation on all motors or equipment.

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6.26 Motor starters:

A. The electrical work shall include the supply, installation and wiring of all relays as required. Thermal overload switches sized to equipment and of melting alloy type.

B. Manual starters: Pushbuttons and pilot lights as required, with fused control circuits. Magnetic contactors shall be in line voltage start, one, two or three pole, with thermal overload protection and under voltage protection in all phases, with a holding contact and one auxiliary contract, unless otherwise required, HOA, start, stop and reset button in the face.

C. The coil operating voltage shall be 120 volt, one-phase (obtain power from a fused transformer unit in the starter, except when in a separate enclosure where a line to voltage coil is acceptable). The enclosure shall be general purpose unless noted, with an external operating handle and a safety interlock to prevent the door from opening when the unit is in operation.

D. The starter and thermal overload shall be sized to the motor operation. The starter and thermal overload shall be sized to the motor being controlled or as indicated and labeled. Show equipment being served, voltage, F.L.A. and heater type and size. All spare starters shall have HOA, 2 N/O, 2 N/C contact pilot lights and control transformers, if required.

6.27 Motor Control Center:

A. Motor control center shall meet the minimum requirements of the latest published standards of NEMA and NEC. Control circuits shall be powered and fused from the unit breaker, so the opening of the breaker de-energizes the control circuit. Horizontal and vertical bus bars shall be braced for appropriate A.I.C. symmetrical amperes.

B. Horizontal Wireways: Standard sections shall have a top horizontal wire trough with an opening between sections.

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6.28 Electrical Service (High Voltage):

A. General: Materials, construction and tests shall conform to the applicable requirements of ICEA and ASTM specifications that are in effect at time of system design. All work on high voltage wiring (2000 volts and up) shall be done by a qualified high-voltage electrician only. No high voltage shall be energized until inspection has been made by the engineer.

B. All cable shall be subject to complete mechanical and electrical inspection by the engineer on the construction site. Any damaged cable will be rejected.

C. Splices and Terminations: Splices and terminations shall be performed by qualified splicers and with the kits as supplied or approved by the cable manufacturer. The engineer shall be notified in advance so that he may observe splices being made.

D. Grounding: The installed grounded conductor shall be grounded at each switch, and transformer with bonds to all metal frames and cases of equipment, racks, supports, etc., to existing ground rods and neutral conductor of primary cable.

E. Test of New Cable and Terminations:

1. The primary cable shall be given a high voltage D.C. test after entire installation and terminations have been completed.
2. Tests shall be made by the Electrical Contractor or those performing the installation with the results forwarded to the Fee Engineer. The test results shall include circuit-continuity and high potential tests.
3. In the event that the results obtained in the tests are not satisfactory, make such adjustments, replacements and changes as are necessary and then repeat the test or tests which disclosed the faulty or defective work or equipment and make such additional tests as the Engineers deem necessary.
4. The electrical tests shall include the following:

    a. Continuity Tests: Each circuit shall be "rung-out" or "talked out" with proper signaling devices and with all equipment disconnected at each end to indicate that it is a continuous circuit where the operating requirements are that it shall be continuous.

b. High Potential Tests of Power Cables: All power cables shall be given d-c high potential test after installation and after potheads or other terminations have been made, but before connections have been made to buses or apparatus. The cable shall be tested as specified by cable manufacturer.

5. If a cable fails, the fault shall be located and cable withdrawn and replaced with new cable. After the replacemet of the faulty cable, the test shall be repeated.

F. Duct Systems:

1. The primary voltage system shall be in raceways. This shall be a minimum. Rigid, galvanized conduit inside buildings and buried concrete encased plastic ducts beneath and exterior to buildings.
2. Concrete-encased ducts shall be installed in pairs (i.e. multiples of 2). A minimum of one spare empty duct with a polypropylene pull wire installed shall be provided.
3. Where bus duct is used for primary or secondary, all connections shall be torqued per manufacturer's recommendations.
4. All bus duct installed or bus bars used in equipment shall be insulated.
5. The first ten foot length of conduit entering buildings, manholes, etc. shall be rigid steel.

6.29 Mechanical Rooms:

A. Lighting and Power Outlets:

1. Lighting and power outlets in Mechanical and Equipment Rooms shall be coordinated with duct and equipment locations.
2. Raceways may be run exposed and no outlets shall be installed above ducts, behind equipment or otherwise inaccessible or unsuited for the purpose intended.
3. Lighting shall be positioned to provide proper illumination in such rooms regardless of where shown on the drawings.

B. Proper access and working space shall be provided.

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6.30 Transformer Vaults:

A. Dry-type transformers rated 112 1/2, KVA and over shall be totally enclosed and self-ventilated and shall be installed with proper clearances.

B. Askarel-filled transformers shall not be used.

C. New and remodeled vaults shall have proper fire sprinkler system, if walls, ceilings and doors are not less than three-hour fire rated. New vaults of all concrete construction need not be sprinklered, but shall have fire detection.

D. Under no condition will pipes, conduits or other foreign items enter or pass through any part of a vault that are not part of the vault.

E. Fire sprinklers shall terminate in vault and not pass through to other rooms or areas of the building.

6.31 Elevators:

A. Under no condition shall any electrical conduit be allowed to enter or pass through any part of an elevator shaft or equipment room that is not part of the elevator or its control. Lighting and outlet required in the elevator pit for maintenance or repair must enter below the car floor level.

B. A fused disconnect shall be installed in the Equipment Room within sight of the equipment.

6.32 Lighting Fixtures General Requirements:

A. Lighting fixtures shall be installed complete with all necessary wiring, sockets, lamps, reflectors, ballasts, auxiliaries, plaster frames, recessing boxes, hangers, supplemental supports, lens diffusers, lamps and other accessories essential for a complete working installation.

B. Outlets for recessed fixtures in acoustical tile ceilings shall be located to center on a single tile or at the intersection of four tiles.

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C. Fixtures and Equipment:

1. External boxes shall be installed for recessed fixtures and where required; connections shall be made by lengths of flexible conduit and proper type of wiring to individual fixture housings or channels.
2. Conduit and building-type wiring may be terminated in junction boxes of pre-wired incandescent fixtures.

D. For all fluorescent fixtures, ballasts shall be externally and individually fused, HPF, for two or four rapid-start lamps, with internal, nonrenewable and nonresetting thermal protection; shall carry the UL label and shall be Class "P", Premium, CBM approved. Equal quality ballasts of proper rating and characteristics shall be furnished for each different size and/or type of lamp. Single lamp, tandem-wired fixtures shall have two-lamp ballasts where applicable.

E. Use power miser or equal lamps and ballast for energy conservation where possible.

F. Fixtures shall not be located over equipment and piping, but shall be positioned to provide proper illumination.

G. Fixture Support:

1. All fixtures will be safety wired from structural member of building, not depending on ceiling grid system where suspended or from wires suspending the ceiling grid system.
2. All fixtures installed on stems over 12" shall have swivels.

H. Fluorescent fixtures shall be no less than 1/2" from combustible materials and shall be grounded.

I. Electric discharge light fixtures shall be equipped with a constant wattage ballast.

J. Outdoor electric discharge light fixtures shall be equipped with a -10 degree F. constant wattage ballast.

K. All outside lighting along walkways, roadways etc. shall be installed using break away fuses in the base for all phase conductors and materials. Neutral fuse holder will use a shorting fuse insert. No common neutral multi-wire circuits will be used to feed this type lighting.

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6.33 Lighting Fixtures and Lamps:

A. Furnish and install lighting fixtures complete with lamps at all lighting outlets. Fixtures shall not be installed until work of other trades in the vicinity will not result in damage to the fixtures. Nicks and scratches on the exposed surfaces of the fixtures shall be repaired using the same methods and materials as the original. All outlet boxes except those for recessed lighting fixtures shall be flush with the final surface finish.

B. Provide the required mounting accessories for the hanging of each fixture. Each lay-in light fixture shall be installed with at least 36" of 3/8" steel flexible conduit.

C. Acrylic diffusers shall be 100% virgin compound.

D. Provide a spare diffuser and/or glass for each light fixture type and one for each additional unit for each ten fixtures. The quantity of any single type need not exceed 10.

E. Coordinate the installation of all light fixtures with the ceiling air diffusers.

6.34 Emergency Systems:

A. A panelboard or disconnect shall feed the following equipment:

1. A rechargeable battery for emergency lighting, fire alarm system.
2. Exit lights, night light circuits.
3. Other equipment necessary for life safety or life support.

B. All equipment connected to the circuits as outlined in "A" shall have an emergency source of power. The emergency source of power can be:

1. Generator set that will provide a minimum of two (2) hours operation of equipment supplied.

C. Emergency circuit wiring shall be kept separate and independent of all other wiring. This wiring shall not enter the same raceway, cable, box, or cabinet with other wiring, except where they connect to the same equipment for two-source operation or backup.

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D. Where generators must be supplied for elevators of a building over 75 feet high, the generator will be sized to supply all emergency power requirements for the emergency system. These will include: Battery chargers for fire alarm, emergency lighting, exit lights and other equipment necessary for life safety or life support systems.

E. Emergency power for elevators shall comply with provisions of the Elevator Division of the State Industrial Commission.

F. Emergency Generators:

1. Generators will be installed with automatic transfer switches tested by the manufacturer of the generator for compatible operation.
2. All generators will be diesel-driven, with a "Day" tank reservoir and low fuel cut-off switch. Two (2) hours of fuel will be provided.
3. All generators will be installed in heated rooms or have crankcase heaters installed for reliable operation.
4. All generators 100 KW and larger will be field tested after installation with a load bank to provide the rated KW of the generator for a minimum of four hours.
5. The generator will be on line in 10 seconds, maximum after a power failure, except for hospitals, where a maximum of 10 seconds is required.

6.35 Hazardous Locations:

A. General - All areas where Classes I, II and III hazardous materials are present will be designated by the Utah State Fire Marshal as to class, group and division. All wiring in these areas will comply with this designation.

B. Wiring Methods and Materials: All conduit will be rigid or IMC. At least five full threads shall be engaged when installed. Inspection fittings shall be provided with explosion-proof drains to prevent water accumulation in conduit runs. All conduit systems will have seals at arcing or high temperature equipment, at housings with splices or taps and where conduit enters or leaves the hazardous area designation. All seals will be of the appropriate type for vertical or horizontal installation. All equipment used will be suitable for the area designation. All metallic parts shall be effectively grounded.

C. Gasoline Pumps: Where a neutral is supplied for equipment of gasoline pumps, the neutral will be switched with the phase conductors to open all conductors to the gasoline pump when disconnecting means is opened.

D. Paint Spray Booths: The exhaust fans of paint spray booths will be interlocked with the air spray or other equipment to prevent their operation until the exhaust fan is operating.

6.36 Auxiliary Systems:

A. General

1. The architect/engineer shall furnish the Owner three (3) complete wiring and connection diagrams, and operating instructions and parts lists, which shall be included in the Shop Drawing Manual. Together with the representative, the Owner and Architect shall make final tests of each component, such as fire detector, break-glass station, amplifier, speaker, clock-correction, etc., and adjustments to set the system into operation. The representative shall instruct the proper parties as to care and operation of the equipment, and write a letter (in triplicate) to the Architect stating that all equipment has been tested and placed in proper working order and instructions of operation given, and to whom the instructions were given.
2. Empty conduit in all systems shall be left with a nylon pull cord installed and ends plugged.

B. Telephone, data, video and telecommunications

1. Coverplates shall be furnished for all outlets. A nylon pull cord shall be installed in all empty raceways. Terminal boards shall be 4' x 8' x 3/4" painted plywood. Provide 4 duplex outlets at each telephone board locations with a minimum of 2-20 amp circuits. Also, provide a #6 ground for connection to this equipment. All equipment shall be installed in a separate lockable room. Air temperature and humidity to this room must be controlled.
2. All work shall be co-ordinated with the Utah State Telepcommunications Office (801-538-3330) and meet their requirements.

6.37 Clock and Program System:

A. Requirement: Any building requiring installation of more than five electric clocks shall be designed for an electronic-coded clock system. A program system, if required, shall also be part of the system.

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B. Installation: All clocks and bells are to be provided with a source of unswitched power. Correction range in any one hour shall be 55 seconds for fast time, 59 minutes for slow time on both an individual and system basis. Correction shall be accomplished at the rate of one hour in one minute. Only those clocks at variance with the Master Control shall be accelerated or stopped as may be required to place them in synchronization with the Master Control. The equipment shall be supplied with special flush outlet boxes and shall have plugs for connecting clocks to circuit.

C. Equipment: The manufacturer's representative shall demonstrate the operation of the system at the time of acceptance. The representative shall also instruct institution personnel as to the care and operation of the equipment. The manufacturer shall also supply six sets of operating instructions, wiring diagrams, maintenance and repair data.

6.38 Sound System:

A. Work by Others: The following work is not part of the work of the Sound System Contractor, but shall be done in cooperation with the Sound System Contractor; all conduit and outlet boxes, including all wiring for power, for the sound system, audio, intercommunication and television systems shall be by the Electrical Contractor.

B. Workmanship: The Sound System Contractor shall be fully accredited and a franchised distributor of sound equipment. The work herein specified shall be done by fully-competent workmen who are experienced in the installation of sound equipment.

C. Submittals: Shop drawings, technical manuals and related materials shall be submitted. Upon completion of the work, the Sound System Contractor shall deliver three (3) sets of documents, including guarantees, repair parts list, service manuals, operating instructions and written or drawn confirmation of any changes.

D. Installation: The Sound System Subcontractor shall furnish all labor, materials and equipment for a complete installation of the sound system. Care shall be taken to insure that all speakers and amplifier circuitry remains constant with proper phasing and polarity. Cable shall be neatly arranged. All cable shield leads shall be tied to appropriate ground terminals. All wire joints and connections shall be made with rosin-core solder or with uninsulated space lugs with screw terminal strips.

E. Equipment: All equipment shall be completely compatible in operation and interconnection. All cable will be shielded for microphones and live level audio circuits. Receptacles shall be located in appropriate boxes.

F. Sound system contractor shall submit qualifications to show five years of installation and service. Submit lists of projects completed within last year to the architect for approval.

6.39 Fire Alarm System:

A. Submit all fire protection systems to the State Fire Marshal's Office (SFMO) for approval. Obtain sign off from SFMO.

6.40 Adjustable Speed Drives:

6.40.1 RELATED DOCUMENTS:

A. The drawings and general provisions of the contract, including general and supplementary conditions and Division 1 specification sections, apply to work of this section.

B. Information contained on the drawings and/or schedules shall detail the additional specific requirements for the Adjustable Speed Drive (ASD) system equipment.

6.40.2 SCOPE OF WORK:

A. It is the intent of this section to set the minimum acceptable requirements for the design, construction, installation, commissioning and vendor support requirements for the ASD systems specified.

B. The ASD installation, harmonic mitigation, and associated equipment coordination and interface shall be provided by a factory trained and certified ASD electrical contractor. Alternately an electrical contractor may operate under the supervision and warranty of an engineer approved ASD/Power Quality supplier for the installation of the ASD system and associated equipment.

6.40.3 CODES AND STANDARDS:

A. The equipment supplied under this specification shall conform to the latest applicable codes and standards of the following:

1. NEC - (NFPA 70) - National Electrical Code.
2. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
3. NEMA AB 1 - Molded Case Circuit Breakers.

4. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
5. IEEE Standard 519-1992 - Recommended Practices for Harmonic Control in Electrical Power Systems.
6. ANSI C37 - Standards for Circuit Breakers, Switchgear, Relays, Substations and Fuses.
7. ANSI C57 - Distribution, Power, and Regulating Transformers. (includes Reactors).
8. ANSI/UL-508 - Standard for Electric Industrial Control Equipment.

B. The fully assembled ASD system shall carry the UL label certifying UL-508 standards. An equivalent safety leveling program by ETL or CSA documenting compliance with these industry standards shall be acceptable.

6.40.4 ACCEPTABLE SUPPLIERS:

A. The following ASD manufacturer's equipment have been pre-approved to meet the products section.

1. Motor Drives International (MDI)
2. Siemens
3. Westinghouse
4. Mitsubishi
5. Alan-Bradley
6. Toshiba
7. Magnetek

B. The following service consultants have been pre-approved to meet the harmonic testing and documentation section.

1. Energy Management Corporation
2. Power Quality Consultants
3. Spectrum Engineering.

C. Vendors wishing to quote other ASD/filter manufactures and/or service companies must have prior written approval from the engineer. If not listed above, the vendor must apply to the engineer for approval 10 days prior to bid date showing a point by point compliance with the intention of this section including actual test and documentation reports from previous projects for all services required on the project.

6.40.5 MATERIAL BOND:

A. A material supply bond is required covering the ASD system equipment and services provided by the vendor on the project. The bond shall assure that all requirements and provisions of the ASD specification are complied with.

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6.40.6 SUBMITTALS:

A. The following information shall be included with the bid package:

1. ASD system and services bid bond.
2. Description of equipment and tests included in bid to meet power quality requirements of section 6.40.12.
3. Qualifications and name of engineering and technical persons responsible for support and warranty on this project.
4. Extended warranty/service contract bid per section 6.40.18.

B. The following compliance and approval forms shall be submitted for approval:
1. Sample installation approval form to comply with section 6.40.15A.
2. Sample ASD system commissioning approval form to comply with 6.40.16A.
3. Sample ASD system training approval form to comply with 6.40.16B.
4. Sample ASD quality assurance program and sample factory test and certification report forms as required to meet section 6.40.11.

C. Shop Drawings: Submit dimensioned drawings of adjustable speed drives showing accurately scaled equipment layouts. Drawings shall include, as a minimum: physical dimensions of each unit; general arrangement with incoming and outgoing conduit locations; schematic; connection diagram sufficient to install system. Drawings shall describe the ASD and show the equipment, features, and accessories that are proposed. Standard and generic sketches are unacceptable.

D. Voltage/Current Report: After installation is complete, including water and air balancing, measure the line side voltage (L-L and L-N) and full load current of each phase of each ASD. Submit report showing field readings of voltage and current for each ASD.

E. Harmonic Distortion Report: After installation is complete, submit a harmonic voltage distortion report.

F. Complete Operation and Maintenance Manuals for the ASD, including operating instructions, supplier information, wiring diagrams, part lists and required harmonic voltage distortion reports shall be provided.

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6.40.7 GENERAL:

A. This section outlines the overall fabrication, performance and functional requirements of ASD's supplied for positive speed control of standard NEMA design B induction motors.

B. It is the intent to obtain non-proprietary designs and hardware that assure modern "state of the art" equipment which provides a high level of performance and reliability for the greatest long term, total value to the owner.

C. Installation, start-up, check-out and all field service of the ASD shall be performed by a certified factory authorized techician.

D. The ASD manufacturer shall be represented by a local factory authorized supplier.

E. The supplier shall demonstrate capability to provide local service and repair work.

F. The supplier shall maintain a complete supply of stock repair parts for each ASD provided.

G. Provide an NEMA 1 enclosure for each ASD. The enclosure shall be either wall mounted or free standing with forced ventilation as required. Mount all components in a single enclosure including, but not limited to, the ASD unit, contactors, door interlocked circuit breaker, static pressure or differential pressure tranducer and controller and/or other items listed on the plans. All components shall be completely wired within the enclosure. Systems requiring mounting and inter wiring of separate enclosures are not acceptable.

6.40.8 SYSTEM DESCRIPTION:

A. The ASD system shall be supplied as a complete, pre-integrated, stand-alone package produced by a single manufacturer regularly engaged in the production of same and who maintains full system support responsibility.

1. The ASD system manufacturer shall integrate all components and equipment required to meet the features and functions as a single UL labeled system. Vendors providing equipment requiring panel shop or job site modifications or additions that would not be valid under the original equipment manufacturer's safety labeling will not be acceptable.

2. Pre-integrated equipment shall include but not be limited to incoming line filters, rectifier units, inverter units, control circuitry, operator interfaces, protective equipment, and other accessories and auxiliary items necessary to meet the highest standards for the type of service.

6.40.9 CONSTRUCTION:

A. Space and Environment:

1. All ASD system components shall be housed in one grounded, dead front, free-standing or wall mounted, NEMA 1 enclosure. The ASD system size shall not exceed the size allotments nor shall any portion of the system exceed a height of 90 inches. Entry shall be provided for incoming line and load cables as required.

2. ASD systems mounted indoors shall be properly ventilated and sized to operate continuously at the job site elevation in an ambient environment of 0?C to 40?C. ASD systems mounted outdoors shall include environment control provisions as required to operate in an ambient of -30?C to 50?C.

3. Mount the ASD components on removable panels within the enclosure as to facilitate removal for maintenance and part replacement.

4. Mount door with a minimum of two hinges with removable pins. Door shall be rigid and large door shall have additional hinges and stiffening steel.

5. Provide door mounted, industrial type, oil tight operator devices similar to those found on motor control centers.

6. Paint enclosure with high grade enamel, a minimum of 50-70 microns thick.

7. Provide an electrical shock warning label to warn personnel that a potential of electrical shock exists.

8. Provide screened or engraved labels on all door operator and pilot devices.

B. Supply Power:

1. All components of the ASD system shall be selected to operate continuously without any system trip or damage based on the nominal power requirements shown. The above conditions must be maintained under the following expected variations:

   a. Plus or minus 10% voltage fluctuation.

   b. Plus or minus 3% frequency variation (5% if served by a back-up generator).

   c. Distorted voltage waveform with less than 7% total voltage harmonic distortion.

2. The ASD system shall employ voltage sag ride-through coordination under normal operating (average load) conditions to prevent nuisance trips with the following utility interruptions (based on preliminary IEEE working group P1346 data):

   a. 0% voltage for 1 cycle.

   b. 60% voltage for 10 cycles.

   c. 90% voltage continuous.

C. Devices and Wiring:

1. The ASD system shall employ door mounted industrial control operator devices, programming unit, and other devices per the layout and as required to meet all functional and feature requirements. Operator pilot lights, switches and pushbutton shall be industrial oil tight standard devices.

2. Control voltage shall be 120 volts or less supplied by machine tool type transformers employing both primary and secondary fusing. ASD control transformer VA sizes shall be increased by 10% or as necessary to accommodate external impedances when plans show connections to external safety interlocks or other control devices.

3. The ASD system factory wiring shall be permanently marked with hot emboss stamping or an equivalent marking system. All devices shall be labeled and identified with correct setting selections. All component identification and wiring shall be documented in the operation and maintenance manual.

D. Load:

1. The ASD system shall be capable of starting and continuously driving the specified maximum motor load as identified.

2. ASDs driving variable torque loads shall be programmed to optimize load patterns which maximize system efficiency and minimize motor heating and stresses. ASDs driving constant torque shall be programmed to optimize load patters for system or process performance.

3. All ASD systems shall have an overload capacity of a minimum of 20% for one minute.

E. Efficiency and Power Factor:

1. The ASD solid state converter and inverter power switching components and controls shall be selected to achieve a 95% efficiency or better at full load and speed. Other auxiliary devices required including filters, line reactors, cooling or heating devices etc. shall be of a design to optimize efficiency.

2. The entire true system power factor (as measured at the input to the ASD system) shall be 95% or better across the operational speed range. A Power Factor that becomes leading under light load conditions (due to PF correction) is acceptable only if voltage rise is prevented from backfeeding to the rest of the system (meaning PF correction must act like a synchronous condenser). The voltage tolerance at the main ASD system input terminals (as specified in Section 6.40.9B1a) shall not be compromised as a result of power factor correction techniques.

F. Protection:

1. Short circuit protection shall be provided to the ASD system through an externally operated, door interlocked fused disconnect, circuit breaker or motor circuit protector (MCP) rated at 65,000 AIC minimum. The door interlocked handle must be capable of being

pad locked in the off position.

2. Overcurrent protection shall be provided in the ASD system through electronic motor overload (MOL) circuits with instantaneous trip, inverse time trip, and current limit functions. These shall be adjustable and optimized for the application.

3. The ASD system shall provide over and under voltage protection, overtemperature protection, ground fault, loss of one phase and control with a microprocessor. These protective circuits shall cause an orderly shutdown of the ASD, provide indication of the fault condition, and require a manual reset (except undervoltage) before restart. Undervoltage from a power loss shall be set to automatically restart after return to normal. The history of the previous three faults shall remain in memory for future review.

4. A terminal strip shall be provided for the customer to interface the ASD with an external alarm or annunciator.

G. System Controls and Interface Terminations:

1. The ASD system requires integrated transducers, controllers, sequencers, bypass methods, filters and communication interfaces among others. Such devices shall be completely pre-integrated requiring the contractor to make only the typical field connections required as customer connections to a terminal strip.

2. Items shown as "future" shall be available from the ASD system manufacturer in kit form for future owner integration into the ASD system.

3. The ASD system customer terminations shall be clearly identified with terminal numbers and a permanent wiring diagram located in the ASD system enclosure.

6.40.10 FEATURES:

A. The following operator control and indication features shall be provided standard as part of each ASD system:

1. Hand-Off-Auto (local start at ASD, remote start with contact closure).

2. Local-Remote speed control (local speed control at ASD, remote speed control through speed reference signal).

3. Frequency (speed) indication.

4. Motor voltage indication.

5. Motor current indication.

6. ASD run indication.

7. ASD fault and diagnostic indication.

B. The following customer connections and interface terminal strip terminations shall be provided standard as part of each ASD system:

1. ASD remote start/stop connection.

2. External safeties connection

3. ASD run annunciation.

4. ASD fault annunciation.

5. ASD speed reference input connection (4-20mA or as shown on drawings).

C. The following parameter adjustments shall be available to tune the ASD system:

1. Minimum and maximum speeds.

2. Acceleration and deceleration times.

3. Overcurrent trip point.

4. Current limit response to overload.

5. Maximum base motor voltage.

6. Input speed reference signal gain and bias.

7. Output speed reference signal gain and bias.

D. The ASD shall be capable for starting into a rotating motor at any speed.

E. The ASD shall auto restart after a power failure.

F. For maintenance purposes, the ASD system shall be capable of starting, stopping, and running with stable operation with the motor completely disconnected (no load).

G. The unit shall contain an output frequency clamp such that minimum or maximum output frequency can be set at desired limits.

6.40.11 QUALITY ASSURANCE:

A. The ASD system manufacturer shall have a quality assurance program acceptable to the engineer. An outline of this program shall be submitted for approval as noted in 6.40.6.

B. Prior to shipping any equipment, the manufacturer shall individually test and certify each unit to document compliance. This certification report shall be submitted as part of the operation and maintenance manual and include the following minimum testing:

1. A visual inspection shall be made consisting of all system components, wiring connections, and safety mechanisms.

2. High pot testing shall be conducted on the completed ASD system including all accessory power components as a complete package. This test shall be conducted per UL 508 (two times the rated voltage plus 1000 volts AC for 60 seconds) using regularly calibrated high pot test equipment.

3. A system run test shall be conducted using an actual motor accelerated and decelerated through the entire speed range.

4. All control panel devices, including switches, pilot lamps, keypad and special control devices shall be functional tested.

5. Special tests shown in the documents, or as later required by the engineer to demonstrate compliance, shall be provided at no additional cost.

6.40.12 IEEE STD. 519-1992 COMPLIANCE:

A. Compliance with IEEE STD. 519-1992 (Recommended Practices for Harmonic Control in Electrical Power Systems) shall be a requirement of this project. Harmonic filters (passive or active), phase multiplication devices, or any other components required to mitigate harmonic voltage and current to IEEE std. 519-1992 published levels shall be an integral part of the ASD system. Designs which are not pre-integrated and factory wired as part of the UL (or equal) labeled ASD system shall not be acceptable.

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1. Designs which employ shunt tuned filters must be designed to prevent the importation of outside harmonics which could cause system resonance or filter failure. Calculations supporting the design, including a system harmonic flow analysis, must be provided as part of shunt tuned filter deign documentation.
2. Designs which cause voltage rise at the ASD terminals must document coordination with the total system voltage variation to eliminate nuisance tripping.

3. Designs which do not provide both true and displacement power factor (measured at the ASD system input terminals) of at least 95% or better at full load are not acceptable. Designs that allow leading power factor at minimum loads which create voltage rise on the line side of the ASD system are not acceptable (see 6.40.9E2).

B. Relevant data for ASD system vendor calculations to meet IEEE Std. 519-1992 requirements are as follows:

1. For the purpose of this Design Criteria, the Point of Common Coupling (PCC) as identified in IEEE Std. 519-1992, shall be the connection at which each individual ASD system (the offending non-linear load) is connected to the electrical distribution system (linear loads). Required voltage and current harmonic distortion measurements shall be taken at each individual ASD system PCC.

2. The load current (IL) is used to calculate the IEEE Std. 519-1992 ISC/IL ratio required for determining acceptable maximum harmonic current distortion table values as reproduced herein. For the purposes of this Design Criteria this calculated current (IL) shall be the total combined full load current of each ASD system supplied as part of this project or the total combined amperage of loads designated as "non-linear."

3. The ASD system vendor is responsible to determine the short circuit current (ISC) available at the PCC through the drawings, through coordination with other equipment suppliers, from the electric utility, and/or from actual job site electrical equipment nameplate or measurement data.

4. As a convenience, the IEEE STd. 51901992 table of current distortion limits for general distribution systems (120 V through 69,000 V) is given below:

CURRENT DISTORTION LIMITS FOR GENERAL DISTRIBUTION SYSTEMS.
(120 V through 69,000 V)

Maximum Harmonic Current Distortion in percent of I_L

Individual Harmonic Order (Odd Harmonics)

I_{SC}/I_L	<11	11≤ h <17	17≤ h <23	23≤ h <35	35≤ h	TDD
<20	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits above.

C. Documentation of IEEE Std 519-1992 compliance shall be part of the commissioning required by the ASD supplier. Actual job site measurements testing shall be conducted at one half and full load and documented in the operation and maintenance manuals. Reports shall include the following data:

1. Data (text and graphical) shall be supplied showing voltage and current waveforms, THD (or TDD) and individual harmonic spectrum analysis in compliance with the above standards.

2. Power quality reports including transformer derate analysis, telephone influence factor, true and displacement power factor, and voltage and current imbalance reports shall be supplied.

D. All ASD suppliers shall obtain pre-approval based on satisfactory completion of previous ASD projects meeting the above requirements. Pre-approval request shall include calculations, test reports and other sufficient data to show the owner/engineer how compliance to IEEE Std. 519-1992 requirements have been met on previous projects and how compliance will be accomplished on this project.

6.40.13 COORDINATION:

A. The electrical contractor shall verify compatibility with other suppliers to coordinate the specified and intended operation with at least the following equipment:

1. Electric motors.

2. Driven equipment.

3. Control system interface.

4. Electrical distribution equipment including transformers, back-up generators and protective relaying devices.

B. The contractor shall submit letter certification from the ASD system manufacturer and motor manufacturer/supplier stating that they have reviewed each application and that the combination will satisfy the application duties required.

MOTOR AND CONTROL TEST RECORD

JOB NO._____ SHEET____OF ____

OWNER_____PLANT_____UNIT____

SYSTEM NO._____ NAME_____

EQUIPMENT:_____
_____

NAMEPLATE DATA

MOTOR

MANUFACTURER_____ SERIAL NO._____
MODEL NO._____ TYPE_____ DUTY_____
HP_____ VOLTS_____ AMPS_____
RPM_____ FRAME_____ INSULATION CLASS_____
TEMP. RISE_____ AMB._____ SERVICE FACTOR_____
BEARING TYPE_____ BEARING NO. _____
ROTATION VIEWED FROM OUTBOARD END: CW_____ CCW_____

STARTER OR BREAKER

MANUFATURER_____TYPE_____SIZE_____OVERLOAD HTR. NO._____

TEST AND SERVICE DATA (Details on Separate Forms)

MOTOR (Date) (Date)

MEGGER	_____	GROUND CONNECTED	_____
LUBRICATION	_____	ROTAION VERIFIED	_____
COUPLING	_____	VIBRIATION	_____

CONTROLS (Date)

STARTER OR BREAKER SERVICED _____
CONTROLS TRIED: DWG. NO._____ REV._____ _____

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6.40.14 EQUIPMENT PROTECTION AND STORAGE:

A. The ASD system manufacturer shall furnish written instructions for the unloading, handling, installation and any special considerations to keep the equipment free from damage prior to the authorized commissioning start-up.

B. The ASD systems shall be received, unloaded, stored, protected and installed by the ASD system electrical contractor.

C. The ASD contractor shall inspect the ASD systems upon delivery and store them in a clean, dry space and as per the manufacturer's requirements. The ASD system electrical contractor shall maintain the factory wrapping or provide an addition heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

6.40.15 INSTALLATION:

A. The ASD system equipment shall be installed and tested under the direction of factory trained personnel as specified in 6.40.2B & 6.40.16. The installation shall be certified based on the approved form submitted as part of section 6.40.6.

B. Properly sized overload elements, fuses, circuit breakers, etc. shall be installed and verified by the electrical contractor for actual motor and circuit protection and documented as part of 6.40.17A.

C. Interlock wiring and connections between the ASD system, motor disconnect switches and safety devices shall be the responsibility of the electrical contractor.

6.40.16 SYSTEM COMMISSIONING AND CERTIFICATION:

A. The ASD system start-up shall be performed by a service technician or engineer certified by the manufacturer. The following adjustments and tests shall be performed as a minimum with certified copies included in the maintenance and operation manual:

1. Verify that all of the input voltages are within the manufacturer's specifications tolerances.

2. Verify that the motor rotation is correct in all modes of operation.

3. Verify all operator devices, programming and monitoring functions to be fully operational.

4. Verify operation of all field signal control connections.

5. Measure and record system output voltage and current at 50% and 100% speed. Tune the output voltage to correspond to motor nameplate rating at full speed. Check full load current measurements against nameplate data.

6. Make all parameter adjustments to tune and optimize the ASD system to the application. Record all configuration values as part of this report.

7. Conduct harmonic tests as identified in 6.40.11. Measurements shall be recorded for each unit with the ASD system off, running at 50% speed, and running a full speed and load.

B. Owner training shall be provided for each model and type of ASD system provided. Training shall consist of both classroom and actual equipment hands-on training. The training shall be certified on the approved form required in section 6.40.6 and included in the operation and maintenance manuals.

6.40.17 DOCUMENTATION:

A. The ASD system vendor shall supply certified as-built drawings based on the required drawings and approved drawing formats included as part of the submittal process (see section 6.40.6).

1. The drawings shall be included as part of the operation and maintenance manual and be of a reproducible quality.

2. Autocad format files of each drawing shall also be included on a floppy disk.

B. The operation and maintenance manuals shall consist of the following instructions and information:

1. Unloading, handling, installation, and special consideration instructions.

2. Operating functional descriptions and operating instructions.

3. Bill of materials with all spare parts ordering information and availability.

4. Factory test reports.

5. Start-up and system commissioning reports per 6.40.16A.

6. Training certification per 6.40.16B.

7. Power quality and harmonic test reports per 6.40.11.

C. The vendor shall provide two owners manuals consisting of catalog sheets listing actual component and part numbers. Manual shall also show test certificates, warranty and service personnel responsible for warranty. Each owners manual shall also contain the following:

1. Vendor information of equipment being supplied

2. Connection information

3. Start up procedure

4. Fault reset instruction

5. Wiring diagrams (power and control)

6. Parts list

7. Test results

8. Harmonic voltage distortion with unit off

9. Harmonic voltage distortion with unit on line

10. Harmonic voltage distortion strip chart recordings

11. Harmonic voltage distortion report

6.40.18 WARRANTY:

A. The ASD system vendor shall supply a complete parts and labor warranty including travel expenses for 1 year from the date of Substantial Completion.

1. The warranty shall cover the entire ASD system including power devices, controllers, filters etc. enclosed as part of the system package.

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2. For equipment or components manufactured by other than the complete ASD system manufacturer, which comprises more than 25% of the cost of the ASD system, the original equipment manufacturer shall be identified with it's nearest office and warrant obligation.

B. In place of the one year warranty, a two year warranty/service contact shall be quoted as an option at bid time. This service contract shall be renewable in two year increments thereafter. The service contract shall be executable by the owner at the fixed bid price anytime during the first 6 month of operation after start-up.

1. The extended warranty/service contract shall include necessary repairs or loaner replacement assuring complete restoration of operation within 24 hours from the time a service call is requested A $200.00 per day penalty shall be applied for failure to comply after the acknowledged service request.

2. The extended warranty/service contract shall include job site visits twice yearly to inspect, clean, tune (optimize parameters) and repair (if necessary) each ASD system supplied under this contract.

3. The extended warranty/service contract shall include basic orientation and operator training review with the owner's designated personal as part of this visit.

4. The extended warranty/service contract shall include a 200% performance bond in the owner's favor for the term of the service contract.

6.40.19 SOURCE QUALITY CONTROL:

A. All materials and equipment provided shall be new and unused.

B. All components shall be UL listed and labeled.

C. ASD shipped directly from the manufacturer shall have a UL label.

D. ASD packages assembled from components by suppliers shall be UL labeled or ETL approved.